NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

ECONOMIC PAPER NO. 49

THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 49

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1913-17, INCLUSIVE

BY

JOSEPH HYDE PRATT, State Geologist

AND

MISS H. M. BERRY, Secretary and Statistician

RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
STATE PRINTERS
1919

GEOLOGICAL BOARD

GOVERNOR T. W. BICKETT, *ex officio Chairman* ..... Raleigh
FRANK R. HEWITT ..... Asheville
JOHN SPRUNT HILL ..... Durham
C. C. SMOOT, III ..... North Wilkesboro
R. G. LASSITER ..... Oxford

JOSEPH HYDE PRATT, *State Geologist* ..... Chapel Hill

LETTER OF TRANSMITTAL

Chapel Hill, N. C., January 1, 1919.

To His Excellency, Hon. T. W. Bickett,
Governor of North Carolina.

Sir:—I have the honor to submit herewith, for publication as Economic Paper No. 49, a report on the Mining Industry of North Carolina, for the years 1913–17, inclusive. In the collection of the statistics for this report, we carried out the arrangement of coöperation with the United States Geological Survey, as authorized by the State Geological Board.

Yours respectfully,

Joseph Hyde Pratt,
State Geologist.

TABLE OF CONTENTS

PAGE

Introduction 9
Useful Minerals of North Carolina 12
Gold and Silver 20
Resumé by Counties 22
The Uwarra Mill, Candor, N. C., by Percy E. Barbour 27
Production 37
Producers and Owners of Mines 39
Copper 40
Production 42
Owners and Operators of Copper Properties 42
Lead and Zinc 42
Production 43
Iron 44
Brown Hematite (Limonite) Ores 45
The Titaniferous Iron Ores 47
Distribution and Character of the Ores 48
Alleghany County 51
Ashe County 51
Caldwell County 51
Richlands Cove Deposit 51
Farthing Deposit 52
Catawba County 53
Davidson County 53
Davie County 53
Guilford County 53
Tuscarora Mine 55
Metallographic Description of Ore 55
Possibilities of Utilizing Ore 56
Trueblood Plantation Ore 57
Apple Plantation Ore 57
Dannemora Mine 58
Lincoln County 59
Macon County 59
Madison County 59
Mitchell County 59
Rockingham County 60
Yancey County 60
Production 61
Owners and Producers of Iron Ore in North Carolina 61
Tin 62
Tin Resources of the Kings Mountain District 62
Introduction 62
Geography 63
Descriptive Geology 64
Piedmont Plateau 64
Kings Mountain District 65
Structure 65
Carolina Gneiss 66
Roan Gneiss 68

PAGE

Tin—*Continued:*
Bessemer Granite 68
Pegmatite 69
Whiteside Granite 70
The Tin Deposits 72
General Features 72
Mines Prospects 75
Gaffney Quadrangle 75
Ross Mine 75
Kings Mountain Quadrangle 76
Localities 76
Kings Mountain Mine 77
Falls Prospect 78
Faires Prospect 78
Plonk Prospect 79
Old Ledoux Prospect 79
Blue Ridge Tin Corporation Main Works 80
Ross Prospect 81
Lincolnton Quadrangle 81
Prospects Along Chestnut Ridge 81
Ormond-Carr Prospect 82
Hovis Prospect 83
Ramseur Mill Prospect 83
Jones Mine 83
Stroup and Rayfield Prospects 84
Hastings Prospect 84
Baldwin and Allen Prospect 85
Production 85
Manganese 86
Clay County 87
Cleveland County 87
Surry County 87
Production 88
Pyrite 88
Production 89
Chromite 89
Production 90
Abrasive Materials 90
Production 91
Producers of Abrasives 93
Mica 93
Uses 94
Localities 95
Production 97
Producers and Owners of Mica Properties 99
Quartz 100
Barytes 101
Production 102
Owners of Barytes Properties and Operators During 1917 102
Monazite 103
Production 104
Owners of Monazite Properties and Producers During 1917 105

PAGE
Zircon 106
Talc and Pyrophyllite 106
Production 107
Producers of Talc and Pyrophyllite During 1917 108
Precious Stones 108
Production 111
Mineral Waters 111
Production 115
Producers of Mineral Waters During 1917 115
Feldspar 116
Feldspar and Kaolin in the Cinchfield's Territory 119
Production 121
Feldspar Mills 121
Producers of Feldspar During 1917 121
Coal 122
Graphite 123
Rare Minerals 124
Greensand 124
Stone 128
Granite 129
Production 129
Sandstone 131
Rhyolite 132
Marble and Other Forms of Limestone 133
Marble 133
Limestone 133
Production 134
Stone Producers During 1917 135
Sand and Gravel 136
Requirements of Glass Sand 136
Building Sand 138
Grinding and Polishing Sand 138
Production 138
Producers 139
Sand Lime Brick 139
Clay and Clay Products 139
Production 140
Clay Tests 141
Kaolin 143
Production 149
Producers 149
Pottery Clay 149
Production 150
Fire Clay and Pipe Clay 151
Production 152
Producers 152
Brick Clay 153
Production 154
Producers of Brick and Tile 158
Summary 161
List of Publications 163

PREFACE

In the following report on the Mining Industry of North Carolina for the years 1913–1917, the Survey has tried to give a concise and accurate idea in regard to the production of the various minerals in the State, and their economic importance. In this connection there are published, in addition to the general information obtained by this Department, several descriptions of the occurrence of certain minerals, that have been prepared and published by men connected with the United States Geological Survey and the United States Bureau of Mines. Although these special reports have been printed in the United States Government publications, it has been thought best to reproduce them in this report, as they are of very great interest to the mining industry of North Carolina, and it was felt that they should be published in such shape as to become available to those interested in the mineral production of this State.

In the absence of the State Geologist, who has been granted a year's leave for military service overseas, this report has been compiled by Miss H. M. Berry, Secretary and Statistician of the Survey. One of the important parts of the report is collecting and tabulating all the statistics regarding mineral production, these being collected in coöperation with the United States Geological Survey. Individual statistics are considered confidential, except in those cases where special permission has been obtained from the producer for their publication separately.

Joseph Hyde Pratt,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1913-1917 INCLUSIVE

By Joseph Hyde Pratt, State Geologist
and Miss H. M. Berry, Secretary

INTRODUCTION*

During the years covered by this report, 1913–1917 inclusive, with the exception of 1915, there has been a steady increase in the total value of the State's mineral production. The decrease in 1915 was due to the general business disarrangement and confusion resulting upon the outbreak of the war in the middle of 1914. In 1916, however, the mineral production increased in value tremendously over that of any preceding year, and in 1917, reached a total of $5,411,452.

There is given in the table below the total value of the mineral production in the State since statistics were first collected in 1900. These figures show a steady increase in the development of the mineral industry of North Carolina.

VALUE OF TOTAL MINERAL PRODUCTION IN NORTH CAROLINA FROM 1900 TO 1917.

Year	Total Value of Mineral Production
1900	$ 1,604,078
1901	1,779,109
1902	2,003,077
1903	1,902,485
1904	1,985,675
1905	2,439,381
1906	3,007,601
1907	3,173,722
1908	2,307,116
1909	2,873,826
1910	2,848,446
1911	2,933,878
1912	3,514,892
1913	3,879,340
1914	3,692,461
1915	3,584,725
1916	4,746,674
1917	5,411,452

*The statistics given in this report, with the exception of gold and silver, copper, lead and zinc, were collected in coöperation with the United States Geological Survey.

In the following table is given a list of the minerals produced in the State and the value of their production during 1912–1917, inclusive.

MINERAL PRODUCTION IN NORTH CAROLINA FROM 1912—1917, INCLUSIVE.

	1912	1913	1914	1915	1916	1917
Stone:						
Granite	983,615	$ 1,116,475	$ 1,286,345	$ 1,246,810	$ 1,798,087	$1,506,541
Sandstone	6,450	3,500	11,172	191,888	52,321	228,048
Marble and other limestones	100,776	140,364	154,888		176,164	213,950
Clay and Clay Products:						
Brick and tile	1,456,703	1,600,723	1,447,994	1,078,541	1,541,576	1,654,832
Pottery	8,950	13,683	12,796	11,394	9,860	7,475
Pottery Clay and kaolin	139,821	139,644	164,837	143,696	151,823	182,176
Mica:						
Sheet	219,874	230,674	171,370	266,650	380,700	543,207
Scrap	36,675	37,239	23,900	33,943	41,880	34,134
Sand and gravel	38,487	127,574	72,989	124,697	150,209	231,813
Gold	166,014	126,448	131,141	173,001	26,237	12,287
Silver	2,985	1,095	844	743	436	915
Copper	10,521	0	2,718	3,005	2,411	34,123
Lead and zinc	25,694	1,142	0	0	0	222
Iron	186,264	211,791	100,917	116,472	249,948	445,898
Manganese						*
Feldspar	*	*	*	*	77,446	131,442
Talc and soapstone	63,304	48,817	28,413	21,501	41,824	41,766
Mineral waters	22,385	23,877	21,964	18,745	19,010	15,664
Abrasives:						
Corundum and emery	10,625	14,772	5,164	12,002	14,489	67,461
Millstones						
Garnet						2,875
Chromite						*
Barytes	*	*	*	*	*	5,080
Quartz	*	*	*	*	*	*
Graphite					*	
Precious Stones	5,655	849	3,070	464	343	75
Tin	*					
Monazite					*	3,806
Zircon	*					
Miscellaneous	a30,104	b40,673	c51,939	d141,173	e11,910	f47,662
Totals	3,514,892	3,879,340	3,692,461	3,584,725	4,746,674	5,411,452

*Included under "Miscellaneous."
aIncludes quartz, barytes, feldspar, tin, and coal, and ores of rare metals.
bIncludes a small quantity of feldspar.
cIncludes barytes, feldspar, and quartz.
dIncludes barytes, feldspar, quartz, and monazite.
eIncludes barytes, quartz, monazite, and graphite.
fIncludes quartz, chromite, manganese, and precious stones.

A review of the above table shows that there has been a steady increase in the value of the stone production during these years, this being due largely to the almost continuous growth of the granite industry. In 1917 there was a slight decrease in the production of granite, but this was more than offset by the large increase in the production of sandstone and limestone over the production of previous years.

For a number of years clay products formed the most valuable of our mineral industries and in the total value stood at the head of the column until 1915, when the value of stone production came first in the order of production of the mineral products of the State. By far the largest part of the clay production was due to the manufacture of common brick.

Third among the mineral products of the State is mica, for which there is a large and increasing demand. During this period of five years there was a steady increase in the value of the mica output, with the exception of 1914, and in 1917, the total production of sheet and scrap mica was $577,341, which is the largest production yet recorded in the State. North Carolina is the largest mica producing State in the country, our mica being known as "standard mica," and considered the best grade mica on the market.

There has been a fluctuation in the values of the production of gold and silver during the past five years, the largest production being made in 1915, and the smallest in 1917. This variation is due to many causes, which are discussed under the head of "Gold and Silver" beyond.

The production of copper in 1912 amounted to $10,521, and then dwindled to nothing in 1914, and less than $3,000 during the next three years. In 1917, however, there was renewed interest in copper mining and the production came up to $34,123.

The most important metallic mineral produced during this period, however, has been iron, although there has been some fluctuation in the total value of its production—there being a decrease in 1914 and 1915 as compared with 1913 and a very much increased production in 1916; while in 1917 the production was almost double that of any previous year, amounting to $445,898.

One of the minerals whose development is comparatively recent in North Carolina is feldspar. The production for 1912, 1913, 1914 and 1915 cannot be given, as there were less than three producers during these years; but in 1916 the producers increased to seven and the production amounted to $77,446. This was nearly doubled in 1917 when the production amounted to $131,442.

Of the metallic minerals it will be interesting to know that productions of chromite and manganese were made during 1917, this being the first time these minerals have been produced in the State for many years.

Of the nonmetallic minerals which are again being produced in North Carolina, corundum and emery are the more notable.

There was a small production of monazite during 1916 and 1917, after several years of nonproduction. The amount produced, however, was very small as compared to the productions of former years.

Other minerals produced in the State during these years are sand and gravel, lead and zinc, talc and soapstone, mineral waters, barytes, quartz, graphite, precious stones, tin and zircon.

The following minerals showed a production in 1917, for the first time, or after a long period of cessation: corundum and emery, chromite, monazite, manganese, and lead and zinc.

The large increase in the mineral production in North Carolina during 1917 is undoubtedly due to the stimulating of all mineral industries because of war necessities; and, because of the demand for raw materials incident upon the period of reconstruction, there will undoubtedly continue to be an increase in the value of the mineral production during succeeding years.

There is given below a list of "Useful Minerals of North Carolina," with their localities, as taken from a bulletin of the United States Geological Survey, and which will be of interest to those studying the mineral industry of North Carolina.

USEFUL MINERALS OF NORTH CAROLINA*

Abrasive. See Corundum, Garnet, Millstone, and Novaculite.

Agalmatolite (pyrophyllite). In Algonkian rocks in a range, crossing Chatham and Moore counties. Worked for use in making wall paper and soaps and in foundries.

Agate. Carrabus County, near Concord and Harrisburg. Mecklenburg County, in small quantity. Orange County, moss agate near Hillsboro.

Allanite. Occurs in Henderson County, at zircon mines near Zirconia. Iredell County, abundant near Bethany Church. Madison County at Democrat. Mitchell County, Wiseman mica mine.

Almandite. See Garnet.

Amethyst. Iredell County at several localities southeast of Statesville. Lincoln County, at Lincolnton, near Ironton Station and Denver. Macon County, in veins cutting gneiss at several places in valley of Tessentee Creek near Scaly Mountain and south of Highlands. Wake County, near Raleigh. Warren County, near Inez, 10 miles south of Warrenton.

Aquamarine. Alexander County, mined at Hiddenite and Ellis mines, near Hiddenite. Burke County, has been found in South Mountain. Jackson County, mined several miles south of Cashiers. Macon County, mined at head of Tessentee Creek. Mitchell County, mined at Wiseman and other mica mines. Yancey County, in Ray and other mica mines.

Arsenopyrite (mispickel). Cleveland County, mined for gold at Kings Mountain mine. Occurs also in gold mines in Cabarrus, Gaston, Union, and Watauga counties, but only sparingly with other ores.

*Taken from Bulletin 624 of the United States Geological Survey on "Useful Minerals of the United States, 1917," by Frank C. Schrader, Ralph W. Stone and Samuel Sanford.

Asbestos. Burke County, occurs near Brindletown and Warlicks Mills. Caldwell County, near Baker mine. Jackson County, southern part; fine and fibrous. Macon County, Nantahala River. Mitchell County, near Bakersville. Wilkes County, near Wilkesboro and Brushy Mountains. Occurs in many other localities.

Auerlite. Henderson County, at zircon mine, in pegmatite, 2 miles west of Zirconia.

Azurite (blue carbonate of copper). At copper mines in Cabarrus, Chatham, Gaston, Granville, Mecklenburg, and Moore counties in small quantity.

Barite. Principal deposits are: Gaston County, about 5 miles south from Bessemer City and in a belt extending southwest parallel with Kings Mountain Ridge. Madison County, near Hot Springs, Marshall, Sandy Bottom, and Stackhouse. Has also been mined in Orange County at Hillsboro.

Beryl. Alexander County, mined at Hiddenite-Emerald mine. Burke County, near Burkmont, in South Mountains. In mica mines in Alexander, Iredell, Mitchell, and Yancey counties. See also Aquamarine.

Bornite (purple copper ore). Cabarrus, Rowan, and Stanly counties, chalcocite in Gold Hill district. Granville and Person counties, important ore in quartz gangue in Virgilina district. Occurs also in Alleghany County, Peach Bottom mine. Ashe County, Gap Creek mine. Chatham County, Clegg's mine. Guilford County, Gardiner Hill mine.

Brown iron ore (limonite, bog iron ore). Many deposits in eastern part of State in Duplin, Jones, Nash, New Hanover, Pender, and other counties.

Brown iron ore (brown hematite). Ashe County has been mined in upper part of Ore Knob copper mines, accompanying copper lodes. Burke County, many beds in a northeasterly direction from Jacobi Fork of Catawba River to Brushy Mountains in Wilkes County; large beds in Chatham County, at Ore Hill. Cherokee County, at Nottla, and along Valley River. Gaston County, Highshoals. Johnston County, near Smithfield. McDowell County, has been mined in Linville Mountains. Many localities have been worked in Buncombe, Burke, Caldwell, Catawba, Gaston, Lincoln, McDowell, Mitchell, Surry, Watauga, and other counties.

Cassiterite (*tin ore*). Tin belt extends from southeastern part of Cleveland County, through western part of Gaston County, to about 4 miles east of Lincolnton, Lincoln County. Cleveland County, has been mined at Jones, Foster, and Fairies mines, near Kings Mountain; and in Lincoln County, near Lincolnton.

Cement Material. Crystalline limestones in western part of State, and soft limestone in Eocene and Miocene, in eastern part of State, suitable for cement.

Cerium. See Allanite, Crytolite, Monazite, Polycrase, and Samarskite.

Cerusite (lead carbonate) Caldwell County, Baker mine. Cherokee County, Murphy. Davidson County, Silver Hill, with galena and silver ores. Rowan County, Gold Hill district.

Chalcanthite (blue vitriol, hydrous copper sulphate). Cleveland County, secondary mineral at Kings Mountain mine, mined for gold.

Chalcocite (copper glance). Cabarrus, Rowan, and Stanly counties, with bornite in Gold Hill district. Person and Granville counties, mined for copper in Virginlina district. Found also in Ashe County, at Ore Knob mine and Gap Creek mine. Cabarrus County, Pioneer Mills mine. Jackson County, Way Hutta and Wolf Creek mines. Swain County, Nichols.

Chalcopyrite. Ashe County, found in Ore Knob mine. Alleghany County, Peach Bottom mines. Chatham County, Clegg mine. In mines of Davidson, Gaston, Guilford, Mecklenburg, Rowan, and Union counties. Guilford County, Gardiner Hill mine. Haywood and Jackson counties, has been mined in Way Hutta, Cullowhee, Savannah, and other mines in copper belt. Lincoln County, Macpelah Church. Orange County, near Hillsboro and Chapel Hill. Wake County, near Raleigh. Watauga County, Elk Knob and Gap Creek mines.

Chalcopyrite (auriferous). Rowan County, Gold Hill district, principal copper ore.

Chromite. Buncombe County, near Democrat and Stocksville. Jackson County, at many places in vicinity of Webster, between Willets and Balsam Gap. Yancey County, in vicinity of Burnsville, has been mined and shipped from Mine Hill.

Chromium.—See Chromite.

Chrysocolla (silicate of copper). Found in many copper mines in western part of State.

Clay. (brick). Common throughout the State. Bricks are made from local clay pits at one or more localities in each of 67 counties out of the 98 counties in the State. Product in 1914 valued at more than $1,000,000.

Clay. (fire). Semirefractory and siliceous clays mined for fire brick in Buncombe County at Emma. Cleveland County, Grover. Guilford County, Pomona.

Clay. (kaolin). Avery County. Gaston County, at Bessemer City (reported). Jackson County, at Sylva and near Webster, at Beta (reported). Macon County, near Franklin. Mitchell County, on Bear Creek, near Penland, at Spruce Pine. Swain County, at Almond and near Bryson City. Yancey County, Green Mountain. Occurs in decomposed pegmatite veins in Smoky Mountain region in western part of State.

Clay. (pottery). Mined in Alamance County, at Liberty. Buncombe County, at Luthers. Burke County, at Morganton. Catawba County. Gaston County, Mount Holly. Lincoln County, Henry and Lincolnton. Randolph County, at Seagrove and Whynot Academy; also mined in Chatham, Johnston, Moore, Union, and Wilkes counties.

Clay. (sewer pipe). Guilford County, at Pomona.

Coal. Dan River area, in Triassic rocks: Carbonaceous shale outcrops from Germanton, Stokes County, to Leaksville; Rockingham County; semianthracite was mined near Leaksville; beds too thin, irregular, and small in extent to be of value. Deep River area; Chatham and Moore Counties, in Triassic rocks; bituminous, 3 feet thick, was formerly mined at Cumnocks.

Columbite. Occasional pieces found in Mitchell County, at Wiseman and other mines near Spruce Pine. Yancey County, at Ray mine, and elsewhere.

Copper. See Azurite, Bornite, Chalcanthite, Chalcopyrite, Chrysocolla, Cuprite, Malachite, Melaconite, and Tetrahedrite.

Corundum. Alexander County, mined to limited extent at Acme mine, near Statesville. Clay County, in peridotite in Buck Creek, Herbert, and other mines. Jackson County, considerable quantity at Sapphire mine, abrasive. Macon County, in Corundum Hill mine, near Franklin, and in Mincey mine, 2 miles Northwest of Corundum Hill. Madison County, at the Carter mine, near Democrat. Transylvania County, good quality in peri-

dotite at Burnt Rock mine. Yancey County, with magnetite, menaccanite, and staurolite, near Burnsville.

Corundum. (emerald, oriental). Found sparingly in Clay County, at Cullakeenee mine, Buck Creek, near Elf. Macon County, Corundum Hill mine.

Corundum (emery). Guilford County, occurs at McChristian place, 7 miles south of Friendship. Macon County, has been mined at Fairview mine, near North Skeener Gap, for abrasive; mined sparingly at several places south of Franklin. Mitchell County, near Bakersville.

Corundum. (ruby). Mined in Jackson County, Montvale. Macon County, at Corundum Hill mine, Cullasaja, Caler Fork of Cowee Creek.

Corundum. (sapphire). Clay County, few found near Elf. Jackson County, Sapphire and Whitewater mines, near Sapphire. Macon County, Corundum Hill mine.

Cuprite. (red oxide of copper). Sparingly in copper mines of Alleghany, Ashe, Caldwell, Chatham, Guilford, Jackson, Swain, Lincoln, and Mecklenburg counties.

Cyanite. Mitchell County, summit of Yellow Mountain. Yancey County, green cyanite at north end of Black Mountains.

Cyrtolite. Henderson County, at Zirconia. Mitchell County, in pegmatites, near Spruce Pine.

Diamond. Ten authentic diamonds have been found in the State: Burke County, two at and near Brindletown Creek ford. Franklin County, two from Portis mine. Lincoln County, Cottage Home. McDowell County, headwaters of Muddy Creek and near Dysortville. Mecklenburg County, Todds Branch. Rutherford County, Twitty's mine.

Emerald. (beryl). Alexander County, Hiddenite mine, near Hiddenite. Cleveland County, Turner mine, 5 miles southwest of Shelby. Mitchell County, Crabtree Mountain. See also Corundum (emerald).

Feldspar. Mitchell County, quarried at Penland. Found in nearly all mica mines of Mitchell and Yancey counties.

Galena. Cabarrus County, McMakin and other mines. Cherokee County, with gold ores, Murphy. Cleveland County, mined for gold at Kings Mountain mine in southern part of county. Davidson County, has been found at Silver Hill, with blende, native silver, etc. Gaston County, with blende in Causler, Shuford, and Long Creek mines. Randolph County, Hoover and Boss mines. Rowan County, Gold Hill district, for gold and silver, Union mine and others. Union County, Long mine. Watauga County, Beech Mountain, several localities. Wilkes County, Flint Knob. Other localities in Alleghany, Burke, Caldwell, Chatham, Macon, Montgomery, Surry, Swain, and Union counties.

Garnet. Burke County, abrasive and gem formerly mined 8 miles southeast of Morganton, along Laurel Creek. Jackson County, abrasive, mined at Sugar Loaf Mountain, near Willets. Madison County, abrasive, mined at Marshall.

Garnet. (rhodolite and almandite). Macon County, obtained with corundum and ruby, near In Situ Hill, on Cowee Creek, and on Mason Branch, 5 miles north of Franklin.

Glauconite. See Marl.

Gneiss. Alexander County, ornamental stone at Rocky Face Mountain. Watauga County, Blowing Rock. Not quarried.

Gold. Gold has been produced in recent years in many localities. There were 12 placer mines and 9 deep mines operating in 1914. Production was valued at $131,141. Burke County, principal production from placers near Bridgewater and Brindletown. Cabarrus County, from reworking dump of old Phœnix mine; also Gorman, Saunders, McMakin, and Reed mines. Catawba County, Catawba and England mines. Cherokee County, Middle branch of Tathams Creek, near Andrews. Cleveland County, has been recovered as by-product in mining for monazite. Davidson County, several mines in Cid mining district. Franklin County, small amount produced at Portis mine. Gaston County, Kings Mountain and Burrell-Wells mines. Granville County, Blue Wing and Copper King mines. Jackson County, Cullowhee mine. Macon County, small amount from placer, near Flats. McDowell County, small amount from placer near Marion, Dysortville, and Vein Mountain. Mecklenburg County, Catawba River, dredge near Charlotte, and Surface Hill hydraulic mines. Montgomery County, Iola mine, near Candor, most important producer in State, 650-foot vertical shaft and 450-foot incline shaft; small production from Old Coggin, Uwharra (old Montgomery), Martha Washington, and Golconda mines. Moore County, small prospects near old Cagle mine. Nash County, small output from Mann-Arrington mine; gold ore found in several prospects near Nashville. Orange County, small yield from North State placer. Polk County, Double Branch mine has five shafts. Randolph County, Scarlett, Talbert, Ashboro, Redding, and Southern Homestake mines. Rowan County, mines in Gold Hill district make small yield, mainly from old dumps; the Steele placer near Cleveland was a producer. Rutherford County, Biggerstaff hydraulic mine near Golden, large producer. Union County, Bonnie Doon and other mines near Indian Trail. See also Nagyagite.

Granite. About 40 quarries operating in 1914 produced granite valued at $1,286,345, located in the following places: Buncombe County, near Asheville. Davie County, Lexington. Henderson County, Balfour. Mecklenburg County, near Charlotte. Polk County, Rockliff. Rockingham County, Ruffin. Rowan County, at Faith; large quarry at Salisbury. Surry County, Mount Airy, very large quarry. Vance County, Greystone. Wake County, near Raleigh. Warren County, 1 mile northwest of Wise siding. Wilson County, Elm City. Also in Anson, Gaston, and McDowell counties, and small quarries, to supply local demand, have been opened at many other places in western part of State.

Graphite. Amorphous, has been mined in Alexander County, at Taylorsville. Cleveland County, at Kings Mountain mine. Haywood County, Waynesville. McDowell County, Graphiteville. Wake County, Method, and in Yancey County. Impure beds in gneiss in Catawba, Cleveland, Gaston, Lincoln, and Rutherford counties; opened near Catawba, Catawba County.

Gummite. Mitchell County, Penland, Spruce Pine, and other places.

Halite. See Salt.

Hematite. Has been mined in Chatham County, Ore Hill. Gaston County, Ormond mine. Harnett County, Buckhorn mine.

Hiddenite. (spodumene). Alexander County, gems mined in veins in biotite gneiss at Hiddenite, associated with aquamarine and emerald.

Ilmenite. Caldwell County, was prospected north of Lenoir.

Iron. See Brown iron ore, Chromite, Hematite, Ilmenite, Magnetite, and Siderite.

Kaolin. See Clay (kaolin).

Lead. See Cerusite and Galena.

Lignite. (brown coal). Common in marl beds in the eastern counties. In Triassic rocks in Anson County, on Brown Creek. Granville County, on Tar River.

Limestone. Produced mainly for burning into lime, and for road metal. Quarries in Craven County, at Newbern; Henderson County, at Fletcher and Hendersonville; Transylvania County, Brevard. Has been quarried in Beaufort, Buncombe, Jones, and New Hanover counties. Other localities known in Cleveland, Gaston, Lincoln, and Stokes counties.

Limonite. See Brown iron ore.

Magnetite. (magnetic iron ore). Occurs in pre-Cambrian formations in central and western parts of State, at many localities. Mined for iron at Cranberry, Mitchell County. Has been mined in Ashe, Caldwell, Cleveland, Gaston, Stokes, Surry, and other counties.

Malachite. (green copper carbonate). Occurs in small quantity in copper mines in western part of State.

Manganese ore. Caldwell County, reported from west of Lenoir. Chatham County, manganiferous iron ore occurs at the Buckhorn iron mine. Cleveland County, small veins and replacements in schists in Kings Mountain region; belt extends northeast into Catawba and Lincoln counties. Surry County, north of Dobson, manganiferous garnet. See also Psilomelane and Pyrolusite.

Marble. Cherokee County, quarried at Murphy. Occurs also in McDowell, Mitchell, and Swain counties.

Marl. (calcareous). Occurs in limited patches in all the eastern counties throughout an area equal to one-fourth of State. Used locally in many places.

Marl. (greensand or glauconitic). Occurs in southeastern counties, from Neuse River to Cape Fear River.

Melaconite. (black oxide of copper). Occurs sparingly in copper mines in western part of State.

Menaccanite. See Ilmenite.

Mica. (muscovite). Deposits have been opened in 18 or more counties in the western part of State, where the production of mica is an important industry. Has been mined and prospected extensively; probably have been over 100 good producing mines. Ashe County, near Jefferson, Beaver Creek, and Elk Crossroads. Buncombe County, near Balsam Gap, Black Mountain, Montreat, along North Fork of Swannanoa River. Burke County, near Burkmont, in South Mountains. Cleveland County, in Indian Town region and near Casar; several miles northwest of Shelby, near Belwood. Gaston County, in northwestern part of county. Haywood County, in Allen Creek basin south of Waynesville, and in Balsam Mountains at head of Pigeon River. Jackson County, a large number of mines in a belt several miles wide, extending northeast across the county from Cowee Bald and Moss Knob, on the Cowee Mountain divide, to Balsam Gap and Richland Balsam Mountain; also near Sols Creek along Tuckasegee River, near Pinhook Gap, Wolf Mountain, and at several places in southeastern corner of county.

Lincoln County, in belt along west side of county. Macon County, in a belt several miles wide, extending northeast across county, from Nantahala River over Wayah Mountain to Cowee Bald and Moss Knob, on the Cowee Mountain divide; also near Higdonville, Scaly, and Highlands. Mitchell County, large number of mines in region between Bakersville, Crabtree Creek, Blue Ridge Mountain, Lineback, and Cranberry; Spruce Pine central point to mica region. Rutherford County, Isinglass Hill, three and one-half miles north of Rutherfordton, and other localities. Stokes County, near Sandy Ridge. Transylvania County, Bee Tree Fork region and near Sapphire. Watauga County, north of Boone and 2 miles northwest of Elk Crossroads. Yancey County, many mines along South Toe River and westward across Black Mountains, near Burnsville and Green Mountain.

Millstone. Anson County, sandstone used as grindstones, during the Civil War. Madison County, quartzite on Laurel River, used for millstone. Moore County, Triassic conglomerates, used for millstone, McLennans Creek. Rowan County, made from granitic rock at Salisbury.

Monazite. Found in gravels in area of about 3,000 square miles. Produced from placers in Burke County, around Bridgewater, Brindletown, Connellys Springs, and Morganton. Cleveland County, Belwood, Casar, Lawndale, Carpenters Knob region, Mooresboro, and elsewhere. Gaston County, Cherryville. Iredell County, north of Statesville. Lincoln County, western part. Madison County, in masses up to 60 pounds in weight near Mars Hill. Rutherford County, Ellenboro, Oak Springs, Rutherfordton, and elsewhere. Also in Alexander and Catawba counties.

Nagyagite. Cleveland County, mined for gold at Kings Mountain mine.

Novaculite. (whetstone). Anson County, has been quarried near Wadesboro. Orange County, few miles west of Chapel Hill, quarried extensively. Person County, near Roxboro.

Peat. Abounds in the eastern part of State, particularly in the seaboard counties. Not used.

Pitchblende. See Uraninite.

Platinum. A belt of platinum-bearing rock is reported extending from Cedar Falls, N. C., to Danville, Va.

Polycrase. Henderson County, in gold washings with zircon, magnetite, etc., near Zirconia.

Psilomelane. Caldwell County, in gneissic rocks, near Lenoir. Chatham County, with iron ore at Buckhorn iron mine. Gaston County, in schist 1 mile southeast of Kings Creek.

Pyrite. Cleveland County, mined for gold at Kings Mountain mine. Gaston County, has been mined as sulphur ore 5 miles north of Bessemer City. Rowan County, mined for gold in Gold Hill district. Union County, at Colossus.

Pyrolusite. (black oxide of manganese). Chatham County, with iron ore at Buckhorn iron mine. Gaston County, in schist 1 mile southeast of Kings Creek, and elsewhere in small quantity.

Pyrophyllite. Moore County, produced by three mines at Glendon for use as talc.

Pyrrhotite. (magnetic Pyrites). Plentiful, generally with pyrite and chalcopyrite in copper deposits in Ashe, Jackson, Macon, and Swain counties. Cleveland County, mined for gold at Kings Mountain mine. Macon County, occurs in gravels of corundum mines.

Quartz. ("rock crystal," clear and smoky quartz in crystals). Found in many counties. Fine crystals have been obtained from Alexander, Ashe, Cleveland, and Iredell counties. Cherokee County, quarried near Ranger for flux in copper smelting and in blocks as filler for acid towers. Gaston County, mined at Oliver mine.

Radium. See Polycrase, Samarskite, Uraninite, and Uranophane.

Rhodolite. See Garnet.

Road metal. See Granite, Limestone, Sand and gravel, and Sandstone.

Ruby. See Corundum.

Rutile. Clay County, in placer on Shooting Creek, east of Hayesville. Macon County, abundant with corundum in gravels of Mason Branch and Caler Fork of Cowee Creek. Fine specimens in Alexander and Iredell counties.

Salt. (brine). Rockingham, Chatham and Orange counties, formerly obtained from wells in Triassic beds.

Samarskite. (yttria ore). Mitchell County, large masses have been found at Wiseman mica mine; sparingly at other mica mines.

Sand and gravel. Dug at following places: Anson County, Lilesville. Buncombe County, Asheville. Cleveland County, Shelby. Gaston County, Bessemer City. Guilford County, Greensboro. Henderson County, Balfour. Iredell County, Statesville. Mecklenburg County, Charlotte. Moore County, West End. Wilkes County, North Wilkesboro.

Sandstone. Only quarry operating is at Sanford, Lee County. Idle quarries in sandstone of Triassic period in Anson County at Wadesboro. Chatham County, Chatham, near Egypt. Orange County, near Durham. Rockingham and Stokes counties, quarries in the Dan River belt.

Sapphire. See Corundum.

Serpentine. Very fine, dark-colored, takes fine polish. Buncombe County, Asheville. Caldwell County, Baker quarry. Clay County, Buck Creek. Also in Forsyth and Wake counties. Yellowish-green variety occurs in Caldwell, Orange, Stokes, Surry, Wake, Wilkes, and Yancey counties.

Siderite. (black band ore and ball ore). Chatham County, beds in Triassic rocks of Deep River opened at Egypt, Farmville, and Gulf. Occurs also in Davidson, Granville, and Halifax counties. Common as gangue material in gold mines, also at some copper mines.

Silver. Recovered in refining gold and copper, produced mainly in Person and Rowan counties. Native silver at Silver Hill and Silver Valley mine, Davidson County.

Soapstone. Many undeveloped masses in western part of State. Ashe County, probable valuable deposits 2 miles west of Beaver Creek, quarried for local use.

Sphalerite. (zinc blende). Cabarrus County, in McMakin mine with galena and silver ores. Cleveland County, mined for gold in Kings mountain mine in southeastern part of county. Davidson County, has been found at Silver Hill with galena and silver ores. McDowell County, in Dobson mine, Cedar Grove, in limestone. Rowan County, small quantity in Gold Hill district. Union County, Lemmon, Long Moore, and Stewart gold mines. Small quantities in Alleghany, Gaston, Macon, Madison, and Montgomery counties.

Spinel. Macon County, found in gravels in Cowee Valley. Mitchell County, gahnite variety in Chalk Mountain and other mica mines.

Spodumene. See Hiddenite.

Staurolite. Good single and double crossed crystals, have some commercial value as curios; found in Ashe County; Burke County, South Mountains; Cherokee County; Haywood County, near Waynesville; Iredell County, Belts Bridge; Macon County, near Corundum Hill; northern part of Wake County, and in many places west of Blue Ridge.

Sunstone. Iredell County, near Statesville.

Talc. Alleghany County, mined near Piney Creek. Cherokee County, was formerly mined at Tomotla. Jackson County, mined at Beta. Moore County, three mines at Glendon mining pyrophyllite. Swain County, mined at Hewitts.

Tetradymite. Burke, Cabarrus, Gaston, and McDowell counties, in minute scales at copper mines. Davidson County, occurs in Allen mine and in Beck's mine west of Silver Hill. Montgomery County, mined for gold at Asbury mine.

Tetrahedrite. Cabarrus County, has been found in McMakin mine with silver, zinc blende, and galena, and in Sudwick mine with copper pyrites. Cleveland County, mined for gold at Kings Mountain mine.

Thorium. See Aurelite and Monazite.

Tin. See Cassiterite.

Titanium. See Ilmenite and Rutile.

Tourmaline. Alexander County, black crystals at Stony Point. Yancey County, at Ray mine and many other localities.

Unakite. Madison County, in the Great Smoky Mountains of the Unaka Range in the slopes of the peaks known as The Bluff, Walnut Mountain, and Max Patch. Also in Yancey County.

Uraninite. (pitchblende). Mitchell County, in Flat Rock mine, in Deake mine, in a feldspar quarry near Penland, and in Wiseman mica mine.

Uranophane. Mitchell County, Penland, Spruce, Pine, and other places.

Xenotime. (yttrium phosphate). Burke County, from gold washings at Brindletown.

Yttrium. See Allanite, Cyrtolite, Polycrase, Samarskite, and Xenotime.

Zinc. See Sphalerite.

Zircon. Burke, McDowell, and Rutherford counties, in gravels of monazite mines. Henderson County, mined near Zirconia. Iredell County, occurs near New Sterling.

GOLD AND SILVER

During the five years covered by this report, 1913 to 1917, inclusive, the production of gold and silver has reached the highest and lowest points of any year since 1887, the maximum production being in 1915, when the total production was $173,744; and the lowest production in 1917, when it had dropped to $13,102.

North Carolina furnished in 1913 the greater portion of the gold output of the Eastern States. In that year there were 17 placer mines in operation which produced 308.53 fine ounces of gold; 7 deep mines and prospects produced 5,808.39 fine ounces of gold; 1,777 ounces of silver, and 20,400 pounds of zinc. There were 11,186 short tons of siliceous gold ores treated in North Carolina in 1913, with an average

precious metal recovery of $10.83 per ton, against 14,358 tons, with an average recovery of $10.62 in 1912.

The mine production in 1914 was 6,343.94 fine ounces of gold, valued at $131,141; 1,524 fine ounces of silver, valued at $843. North Carolina furnished in 1914 the greater part of the gold output of the Eastern States. Of the total production during this year, 12 placers produced 324.45 fine ounces of gold, and 9 deep mines and prospects produced 6,012.91 fine ounces of gold; 1,467 ounces of silver, and 20,434 pounds of copper. There were 19,441 short tons of siliceous gold ores treated in North Carolina in 1914, having an average precious metal recovery of $6.43 a ton.

During 1915 there was produced in the State 8,320.55 ounces of gold and 1,465 ounces of silver. Of the gold, about 95 per cent was obtained from siliceous gold ores, and the remainder from placer deposits. Of the silver, about 97 per cent came from siliceous gold ores, and the balance from placers. The gold ores treated yielded an average of $6.65 a ton in precious metals.

The year 1916 marked the beginning of the decline in the production of precious metals in North Carolina. During this year there was produced 1,269.22 ounces of gold and 663 ounces of silver. Of the gold, about 70 per cent was obtained from siliceous gold ores and the remainder from placer deposits. Of the silver, about 90 per cent came from siliceous gold ores and the balance from the placers. The gold ores treated yielded an average of $4.90 a ton in precious metals. The large decrease in the production of gold in North Carolina during 1916 is due largely to the suspension of operations at the Uwarra and Martha Washington mines in Montgomery County.

The production of gold continued to decrease in 1917, when the amount of gold obtained was 589.55 ounces. There was an increase, however, in the production of silver which amounted to 1,110 ounces. Of the gold, about 67 per cent was obtained from siliceous gold ores and the remainder from placer deposits. Of the silver, about 97 per cent came from siliceous gold ores. The gold ores treated yielded an average of $5.00 a ton in precious metals.

The gold obtained from North Carolina is very fine, carrying but a very small amount of silver. Nearly all of the silver credited to North Carolina comes from copper ores. This accounts for the large percentage increase of the silver production in 1917, when there was an increased copper production.

There is given below a brief resumé by counties of the operations of the gold and silver mining industries for the years covered by this report.

Resumé by Counties

Anson County: There was a very small production of gold from Anson County during 1914, but nothing has been reported from this county since that time.

Burke County: There was a production of gold from the Brindletown placers, near Bridgewater, in Burke County, in 1913 and 1914. During 1915 there was also a production from the Pilot Mountain placers at the western end of the South Mountains, where placer gold was obtained by hydraulic and ground sluicing, the principal yield being from Brindle and Suttewhite creeks. There was a small amount of gold obtained from this same section in 1917.

Cabarrus County: There was a small production from the placer deposits of Cabarrus County during the whole five years covered by this report. In 1915 the output was mainly from the Klutz and Litaker mines, near Concord, and the Saunders mine, near Bost's Mills. In 1917 it was reported that new interests are investigating the Pioneer Mill mine of Cabarrus County. Captain Thomas G. Jones reports in 1917 that he is opening up a property 12 miles south of Concord, owned by Charles McDonald, of Charlotte. He reports a deep shaft down 70 feet. Their equipment consists of a 5-stamp mill, 5 plates, 1 Bartlett concentrating table, 15-H. P. boiler, and 10-H. P. engine, with shafts, pump, etc.

Caldwell County: The Niebelung prospect near Lenoir, in Caldwell County, made a small output of gold in 1913. The operations were by hydraulic washing and crushing in a 5-stamp mill. The deposits are described by the manager as "free-milling gold quartz stringers in slates." In 1914 there was a production from the McKenzie mine at Hartland. Here there is a 5-stamp mill in operation and the gold was recovered by surface washing. There were small productions in Caldwell during 1915, 1916, and 1917.

Catawba County: There was a small output of gold from the Wheeler-Edwards placer in Catawba County in 1913 and 1915, there being no report of productions for the other years.

Davidson County: The Ore Knob mine in Davidson County was worked during 1917. The slag and tailing dumps at the Silver Hill mine, Davidson County, were re-worked during the same year, though only small shipments were made, owing to car shortage.

Franklin County: It was reported in 1914 that preparations were being made to resume both hydraulic and deep mining at the Portis mine, near Essex, Franklin County. This mine was reopened in September, 1915, and considerable work was done by steam shovels, discharging in rolls, crushing to one-eighth inch; but the mine was shut down in 1916, after considerable prospecting and experimentation.

Gaston County: There was a nominal output of gold in Gaston County during 1913. In 1915 it was reported that the old Catawba mine south of Kings Mountain, Gaston County, was under development part of the year and produced a small output of gold and silver. One other property east of Kings Mountain also produced a little gold. The discovery of gold ore on the Sandsig farm, east of Kings Mountain, was prospected by several shafts and cuts in 1915. There was no production, however, reported from this county in the two succeeding years.

Guilford County: In 1913 it was reported that on the Dickens property, adjoining the old Fentress mine in Guilford County, a new shaft 70 feet deep, disclosing a considerable vein of quartz, carrying gold associated with pyrite, was sunk. In 1914 preparations were made to work the old Gardner Hill mine and dump near Greensboro, and the erection of a 10-stamp mill was begun. In 1914 it was reported that work on this property was confined to unwatering and cleaning out old shafts to the depth of 228 feet and sampling same.

Iredell County: A small output of gold was reported from small prospecting operations near Mooresville, Iredell County, in 1913. There was no further report from this county during succeeding years.

McDowell County: A small production of placer gold was reported from near Dysortville, McDowell County, in 1913, 1914 and 1917. The Valley Mining Company is operating this mine by hydraulic method. They have two cutting pumps capable of developing 150 pounds pressure on 1½-inch nozzle with centrifugal for moving the earth.

Mecklenburg County: There was a small output of surface gold in Mecklenburg County during 1913, one nugget being found in a cotton field during picking season. In 1914 the Thornton Lead and Steel Company operated an approximately 5-ton smelter near Charlotte, on North Carolina ores and residues for a short period, and some copper matte was shipped. During these years some gold was obtained as a by-product by the Catawba Sand and Gravel Company's dredge on the Piedmont placer. The Rudisil Mine has not been operated for several years, and during 1917 the shaft hoist and all machinery on the property was destroyed by fire. There is quite a large ore dump on the property.

Montgomery County: This county has been for many years the largest gold producing county in the State, and a brief review of the status of the different mines will be of interest.

In 1913 some development work was reported on the old Carter mine which is said to have disclosed three veins with promising values in gold. The property is on Little River and a suitable dam site and favorable outlook for waterpower were reported. This mine has not become a producer, however, during the period of this report.

The well-known Iola or Candor mine, for several years the largest gold producer east of the Black Hills, made a somewhat decreased production in 1913, part of the output being from the reworkings of old tailings. There has been no further report of a production from this mine. The principal vein in this mine strikes N. 45° E. and dips N. 45° W. The ore bodies are reported to dip out of the Iola ground and into the Uwarra (Montgomery) territory on the northeast, and the Martha Washington ground on the southwest. The Golconda vein, striking parallel to the Iola and lying southeast of it, appears to cross the Iola ground, but has not been developed there. The Iola mine is opened by 5 shafts and extensive drifts to a depth of 650 feet and is equipped with a 50-ton mill and modern cyanide plant. The stamps, weighing 1,750 pounds each, are the heaviest used in the

United States. The equipment includes Dorr classifiers, tube mill, Parral agitators, and Kelly filters. The ore is both sulphide and oxidized. One statement of treatment costs gave $1.005 per ton for milling and $0.635 for cyaniding.

The Iola mine was sold in September, 1914, to the owners of the adjoining Martha Washington mine, into which, as stated, the Iola vein both strikes and dips.

No operations were reported at the Martha Washington mine in 1913 and 1914, but in 1915 this mine was a small producer. In 1916, however, work was reported as having been abandoned on this property.

The Uwarra (Old Montgomery) mine adjoins the Iola on the northeast and the workings are in an extension of the Iola vein. There are two shafts, one 400 feet deep to the northwest of the outcrop. The property is developed by 5,000 feet of drifts and was equipped in 1913 with a 50-ton fine-grinding and cyaniding plant, at a cost of $50,000. Crushing and grinding with any cyanide solution and mechanical agitation will be practiced. The mine was operated extensively during 1913, but the mill did not begin operation on the ore until the last day of the year. Both mine and mill were operated extensively during 1914 and made a good output. It was also operated in 1915; but for only a few months during 1916, in which year it was shut down. There was no production from this property during 1917.

The ownership of the Old Coggins mine has changed in recent years, and the property was actively and very successfully developed in 1913. The mine was opened in 1913 by an inclined shaft 268 feet deep and by about 1,000 feet of drifts and crosscuts. It was equipped with a 10-stamp amalgamation and concentrating plant erected in 1913 to replace the former plant destroyed by fire in 1912. The ore was crushed, stamped, amalgamized and concentrated. Free gold was recovered, the gold-bearing sulphide concentrates stored for shipping, and tailings were impounded for future treatment. The mill installed had 10 stamps of 1,050 pounds each and a daily capacity of 40 tons. Some work continued at this property during 1915, 1916 and 1917, but it was mostly development work.

The Sallie Coggins prospect was idle in 1913. The property was originally worked in a small way for its free gold ores, but it is understood that sulphides predominate. This property was operated in 1915, but there is no further report of operations since.

The Hooper Gold Mining Company in 1914 was developing a prospect near Fisher. Two shafts were sunk and a 5-stamp mill was built which was not producing in 1914. The only placer gold reported was by N. R. Stafford from bench gravels near Troy.

Apparently the Rich Cog, Steele and Reynolds mines were the only properties under development in Montgomery County during 1917.

Moore County: The El Oro Mining Company, Inc., of Hemp, Moore County, reported in 1917 that they were doing deep mining through two shafts, one inclined and one perpendicular, using drifts and overhead stopes. They had a steam hoist and skip for inclined shaft, steam hoist and pocket for perpendicular shaft, air compressor and air drills. It is stated that they are completing a 75-ton mill, using the amalgamation process for extracting the gold and silver content of the ore, after grinding to 40-mesh in a ball mill, concentrating and cyaniding the concentrates. At the time the report was made it was stated that they expected to be in operation and make their first production within 30 days.

Nash County: Considerable prospect work was reported from Nash County during 1915. The Braswell Mining Company, of Nashville, reported that they had sunk a shaft about 20 feet, but were not very much encouraged by what they had found. There has been no further report of developments in this county since that date.

Polk County: The Double Branch mine, 9 miles southeast of Landrom, South Carolina, was prospected during 1914, but no further development has been reported from this mine.

Randolph County: The Old Scarlet copper mine in Randolph County, near Asheboro, was under option to the Tenvanoca Copper Company in 1913. A surface mine plant, engine, boilers, compressors, and machine drills were installed. On July 1, 1917, this property was taken over by the Fisher and Corozva Brothers Company, of Baltimore, Md., under option lease. New equipment was added, including large ore bins, 60-ton unit smelter, one sorted for smelting higher grades and concentrating lower grades.

The Southern Homestake and other properties were idle during this time, but development in this and several other prospects was reported as in view during 1913.

Rowan County: The gold production of Rowan County in 1913 was due to small sluicing operations. The Gold Hill and Union copper mines at Gold Hill made no production in 1913, but were producers in 1914. The shaft at the Gold Hill mine was reported in 1914 as being 755 feet in depth and a 40-stamp amalgamating and concentrating mill with a capacity of 60 tons had been installed. This mine was in operation during the first half of 1915, chiefly on siliceous gold ores which carried a small amount of copper and which was saved by concentration. In August, 1915, it was reported that mining operations had ceased. The only gold obtained from this county since 1915 was from re-working the old dumps and a little from sluice operations.

Rutherford County: The Biggerstaff mine, near Golden, became an active producer of placer gold in 1913. In 1914 this was the largest yielder of placer gold in the State. In 1915 it was stated that hydraulic giants were used at this mine against an eleven-foot bank, of which approximately 9 feet is overburden. A 2-mile ditch supplies water under a head of 200 feet. The gold is saved in ground sluice and is not much waterworn. The Biggerstaff and Melton mines near Golden are owned by W. E. Sudlow and

were reported in 1916 as the largest producers of placer gold in the State, which reputation was maintained in 1917.

Stanly County: A little placer gold was recovered from deposits near New London, in Stanly County, during 1915, 1916, and 1917.

Union County: The Old Colossus or Howie mine, near Waxhaw, the principal mine in Union County, was actively developed for five months in 1913, and, it is reported, was opened by a 355-foot vertical shaft and a 100-foot adit. The property was equipped with a 50-ton all-sliming cyanide plant, in which continuous agitation and decantation were practiced. The ore is sulphide with siliceous gangue and is oxidized to a depth of 40 feet. In 1914 the greater portion of the gold production from this county came from this mine. The mill was operated intermittently in 1914 for about four months. In 1915 the Howie was also the largest producer in Union County. In November of 1915 a 300-ton cyanide plant was built at this mine. It uses the Dorr system, which is said to have made an excellent recovery for the siliceous gold ore. In 1916, however, fire destroyed the shaft house of the Howie mine, which was not repaired until December, 1916. This made it necessary to unwater the mine, construct concrete retaining walls and piers to support the permanent head frame, and on March 12, 1917, the secretary of the company reported that they had, at the time of writing, almost completed the wall. He states: "Our mill will start within the next six weeks on a 50-ton daily basis, and we resume mining operations this week, using a temporary head frame and sinking winze on the Bull Face ore body at the third level; and following on the ore chute at an incline. Development work will also be pushed, as well as the dragging of ore from other exposed ore bodies on each of the levels. The Bull Face ore, which runs from $40 up, will be shipped to smelter until we have installed concentrators."

The Wentz property, near Matthews, made a nominal output from prospect work in 1913. The Davis mine, owned by the Mint Hill Gold Mining Company of Matthews, R. F. D. 26, was leased to the Mogul Mining Company of 100 Broadway, New York, in 1916. They reported in 1916 the sinking of a 200-foot vertical shaft. They are using the Ingersol-Rand jack hammers and have installed a steam hoist and compressor, boilers, blacksmith shop, sinking pump, etc. In 1917 they report that work has been discontinued.

In 1916 Mr. J. L. Younts reports that the Black Mine at Indian Trail was being unwatered by Mr. E. L. Propst, of Charlotte. He stated that the main shaft is 175 feet long at a 120-foot depth. It was expected that the mine would go to work as soon as the water was out, but no report to this effect was received in 1917.

Yadkin County: Some underground development work was reported at the Gross and Dixon mine near Cana, Yadkin County, in 1914, and an air compressor and drills were added to the equipment, which includes a tube mill of 25 tons capacity.

The Uwarra Mill, Candor, N. C.*

BY PERCY E. BARBOUR, MINING ENGINEER

The Uwarra Mining Co. owns and is operating a gold mine about 2½ miles from Candor, Montgomery County, N. C., and has just completed and put in operation a modern fine grinding and cyaniding plant of 50 tons capacity, which has several interesting points of divergence from general practice. Not the least interesting feature of this property is its location in an agricultural, cotton and peach raising country. The points of technical difference are considered by the company to be strides forward in the practice of the treatment of gold ores; the extraction now obtained, which varies from 94 to 97 per cent, is mentioned here to anticipate any hasty criticism of the details to be given.

Ore Occurrence

The ore occurs in fissure veins in a hard greenish-black diabase, which latter has been much broken by jointing and along the zone of fissuring has attained a slaty cleavage so distinct as to give the name of slate to the country rock as a whole, which, however, is properly diabase.† There are two veins on the property, which in places are 6 feet wide, but which will average about 2 feet, and one of these has ore of commercial value developed by underground works for over 800 feet on the strike. The ore is a hard quartz, pearly gray in one vein and streaked with red in another, but in both cases hard and tough. The walls are in places well defined, but in others they are frozen to the vein and, either way, much slate is unavoidably broken down while stoping, so that hand sorting has to be resorted to both underground and on top. Of the rock as broken underground, 10 per cent is sorted out by the muckers and sent up as waste. Later on this will be left in the old stopes, but conditions prevent it at present.

The mine cars leave the cage at the landing station, about 8 feet above the collar of the shaft, and are trammed across a trestle 117 feet long to the crusher bin and are there dumped on to a flat grizzly with bars set 1½ in. apart. There are four ore pickers here who pick out 16 to 20 per cent more of the coarse slate, which goes into the waste pocket of this crusher bin. This bin was the stampmill bin in the former company's old Montgomery mill, and because of its perfect condition was removed and utilized in the new plant, though not exactly what would have been provided if a new one had been built; however, it serves the purpose very well.

**Engineering and Mining Journal*, October 24, 1914, page 729.
†Private communication from Joseph Hyde Pratt, State Geologist, Chapel Hill, N. C.

Handling the Ore

The ore is drawn from this bin through a standard 24 x 24-in. single rack-and-pinion steel-plate gate and passes over an inclined grizzly with 1-in. opening to the crusher. The material through the grizzly drops directly to the loading hopper of the conveyor, to which also comes the product from the crusher, which is of the standard Blake type, size 15 x 9 in., set for 1¾-in. product. The jaw plates are of chrome steel.

This crusher is separately driven by a 7 x 10-in. Chandler & Taylor medium speed throttling engine, horizontal type, and the engine and crusher are housed together in a crusher building separate from the mill but connected with it by the conveyor structure.

From the crusher and last grizzly, all ore is carried by a 14-in. wide trough belt conveyor, 88-ft. centers, traveling on an incline of 20° and at a speed of 250 ft. per minute. This conveyor has a capacity much in excess of present needs, but was provided for future expected increase in tonnage from the mine. The belt is a four-ply S. A. special conveyor belt with ⅛-in. rubber cover on the carrying side.

This conveyor is driven from the main mill shafting and discharges the ore into a cylindrical steel ore bin, 12 ft. in diameter by 20 ft. high, which is the only ore bin of this type in the East. This bin is without top or bottom, but is reinforced around both top and bottom with angle irons. The bin is supported on a concrete foundation, which was made duodecagonal in shape, instead of circular, to save the cost of circular concrete forms, and with walls 12 in. thick and 6 ft. 6 in. high. It was intended to reinforce this wall with expended metal, but a long delay in its arrival made a substitute necessary and heavy hogwire fencing, secured from a local hardware store, was used in its stead with entire satisfaction. The inside of this duodecagonal foundation was filled with loose rock from the dump and a 2-in. layer of cement grout on top made the bottom of the bin. This bin is just outside of the main mill structure. The ore from this bin is drawn through a standard 18 x 24 in. rack-and-pinion gate and fed by a 16 x 6-in. plunger feeder with adjustable eccentrics to the crushing rolls.

Crushing Methods

We think this is the first modern all-sliming cyanide plant to use rolls exclusively for wet crushing between the rock breaker and tube mill. A great deal of study, of course, was given to the selection of these crushing units. I have long been of the opinion that the stamp was out of place for this particular kind of stage crushing, for various

reasons. To H. W. Dennison, of the Allis-Chalmers Manufacturing Co., who collaborated with me in the design of this plant belongs no little of the credit in the choice of these rolls. However, the adjoining mine, the Iola, owned by the Candor Mines Co., has been operating a mill[1] using 1,750-lb. stamps, the heaviest in this country. The use of heavy stamps in our mill would have been objectionable also because our only mill site was on the hanging wall of our vein, not far from the shaft; this was one more argument in favor of a rotary crusher. Various types were considered, but rolls were finally adopted, and while at this writing the mill has been in operation but 90 days, our judgment in the installation of rolls seems to have been fully justified.

Two sets of 24 x 10-in. Allis-Chalmers, style B rolls were installed and operate under real wet crushing conditions, five tons of solution to one of ore going through rolls. The roll shells are of low carbon steel. These rolls are not provided with automatic fleeting devices,[2] which were carefully considered but finally omitted.

Our first set of coarse rolls getting the product from the Blake crusher set at 1¾ in. naturally gets a very variably sized feed; the slate and slaty ore break into pieces, some of which may be 3 or 4 in. long and 2 or 3 in. wide, although only 1¾ in. thick. It is severe service to feed such material to rolls. However, some of our rock goes to the rolls thus, and we have little or no trouble from them now that the feeders, both mechanical and mortal, have been properly adjusted.

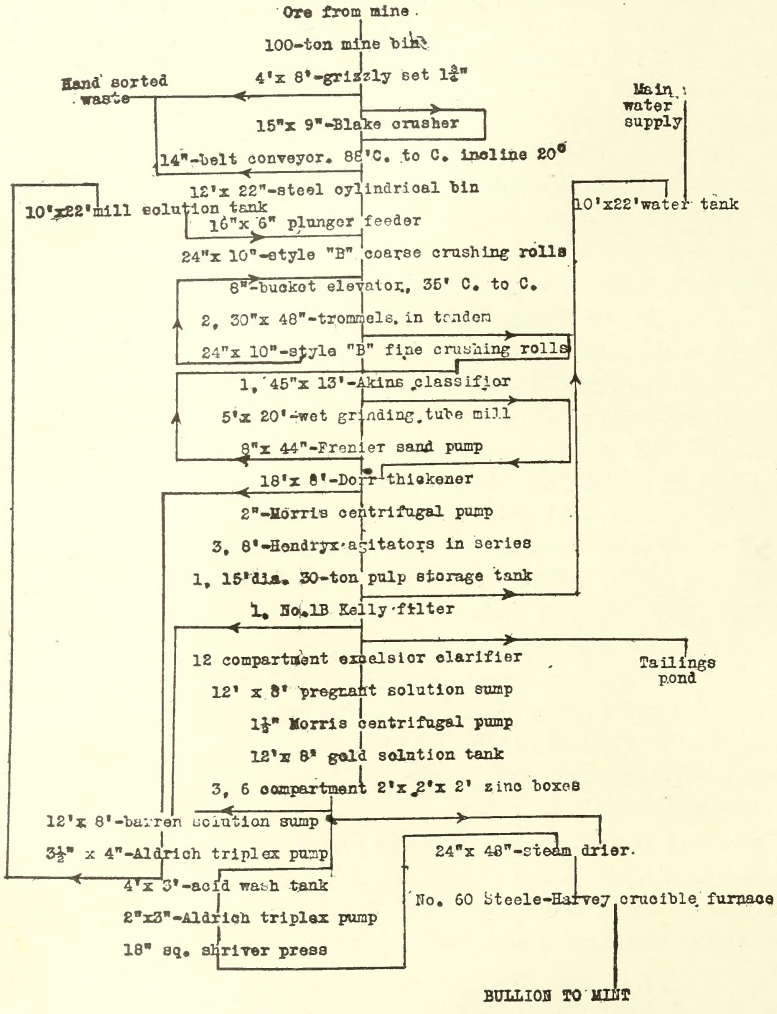
Quoting from Mr. Holthoff's article, "Without abrasion there can be no corrugating. Abrasion is due to two causes, first, if the material fed is coarser than the rolls can nip without slipping; second, if the roll faces are running differential." Some of our feed, on account of the cleavage of our rock, is probably too coarse from the above standpoint, and we expected corrugations, but at the end of 90 days we have only very slight corrugations on our coarse rolls; but on our fine rolls, where the feed is more uniform and none is too coarse, our roll shells are as smooth and straight as can be desired. In this connection it must also be considered that our labor supply is drawn from local circles and we are operating with men who never saw a set of rolls before. Considering this and the tough and abrasive character of our quartz ore, we consider this a satisfactory result and we expect to take these corrugations out by hand adjusting and by regulation of the feed without the necessity of machining the shell. We cannot tell yet what the steel

[1]Iola cyanide mill, by Percy E. Barbour, *Engineering and Mining Journal*, Sept. 14, 1912.
[2]Mr. Holthoff, in *Engineering and Mining Journal*, Vol. XCV, p. 1302, 1913, argues strongly against any fleeting device.
Mr. J. Parke Channing, in "Bull. 31" of the Mining and Metallurgical Society, states that the Miami has finally developed a fleeting device which fleets the roll once in 30 min., and by this slow movement entirely eliminates all the previous troubles had with various devices of this kind.

consumption will average per ton of ore, but present indications are that it will be satisfactorily low.

Screening and Classifying

The product from both sets of rolls is elevated by an 8-in. bucket, vertical-belt elevator, 35-ft. centers, which discharges it into a set of two 30 in. diameter by 48 in. long standard trommels set in tandem; the first screen of 3/16 metal has 1/2-in. round punched holes and the second of No. 10 steel is perforated with 3/16 round holes.[1]



Flow Sheet of Uwarra Mill

[1]This screen will be changed for one of woven wire, ¼-in. mesh, in order to get a coarser feed for and put more work on the tube mill.

All oversize is returned by launder to the coarse rolls. All the screen product goes to the fine rolls and the fine material through the last screen goes to an Akins classifier, 45 in. diameter by 13 ft. long. The choice of this classifier was influenced largely by the fact that it had so few bearings to care for, oil and maintain, compared to some others, and as for results accomplished, it has seemed to us that honors were pretty evenly divided. This classifier is giving satisfactory results as to classification and is giving a tube mill feed so dry that it is necessary to add solution.

The coarse sands from the classifier discharge directly into the feed box of the tube mill, which is of the gear-driven trunnion type, equipped with spiral feeder and reversed screw discharge. It is lined with Montana Tonopah iron bibbed lining. Danish flint pebbles are used.

The tube mill product is raised to the Akins classifier by an 8 x 44-in. standard Frenier pump, thus forming the usual closed circuit at this point in the flow sheet.

The overflow from the classifier goes to a Dorr thickener with steel tank 18 ft. diameter by 8 ft. deep, the overflow solution from which goes to a sump tank 12 ft. diameter by 8 ft. deep on the lowest bench of the mill, and is pumped back to the solution-storage tank, 10 ft. diameter by 22 ft. deep, located on the roll bench inside the mill building. For this service a 3½ x 4-in. Aldrich triplex pump, belt-driven, is used.

The thickened pulp from the Dorr is handled to the agitators by a 2-in. Morris centrifugal pump. We are considering the replacement of this pump by a Frenier because the abrasiveness of this ore is so great as to cause excessive wear on the rapidly revolving centrifugal and the latter cannot be operated satisfactorily on this small tonnage to give continuous flow to the agitators, which is necessary for continuous agitation.

The Agitators

There are three Hendryx 8-ft. diameter steel shell agitators, arranged for continuous agitation. This type of agitator was selected after an exhaustive series of tests in small agitators of the Hendryx type. A mechanical agitator was preferred to any other because it was desirable to eliminate the use of compressed air, first on account of certain local conditions and second on account of the cost of compressed air, not only considered *per se,* but also considered as to its compression in a steam-driven straight-line machine versus agitation by mechanical power from the Corliss engine of the mill. These tests, which I hope to publish later, demonstrate the efficacy of this type of agitator for these ores and the actual operation thus far bears out the result of the tests very closely. The agitation period is about eight hours to obtain

the extraction as given, varying from 94 to 97 per cent. These agitators have steam coils inside the tank and the pulp is kept heated to about 90° since our tests showed that this degree of heat was a decided advantage in accelerating extraction. The steam main from the boiler plant to the mill engine is a long one, and is carried in an insulated buried box on a considerable incline. The heating pipe for the agitators is taken off from this steam line in the engine room in such a way as to trap all the water of condensation in the line and we thus save much heat which would otherwise be lost. The power consumption of these three agitators, as shown by indicator cards, is 10.9 hp., which is certainly satisfactorily low.

The Filters

Owing to the fact that the filter works only during the day shift, a pulp storage tank between it and the agitators is necessary to hold the accumulation of the night shift mill run. This pulp storage tank is 17 ft. in diameter by 10 ft. high, with a conical bottom 9 ft. 6 in. high from the inverted apex of which the pulp is drawn to the filter. This pulp storage tank is provided with an overflow launder and a decantation device, which not only allows for sending a thick pulp to the filter, but also allows the removal immediately of a large amount of the pregnant solution without sending it through the filter.

The filter is a No. 1, type B, Kelly press, and it handles in one 12-hour shift the 50 tons of dry slime ground per day. The operation of this filter and the results have been quite unusual. The solution is expelled from the cake until it contains only 8 per cent moisture and the cake is then discharged as tailings without any washing whatever. The tailings as discharged, including both dissolved and unextracted values, often run as low as 20c. and for the current month will average about 36c. per ton of ore.

The pregnant solution from the filter goes to a 12-ft. diameter by 8 ft. gold sump tank and is then pumped by a 1½-in. Morris centrifugal pump through an 18-in. square-frame Shriver filter press for classifying, from which it goes into a 12-ft. diameter by 8-ft. gold tank, from which it flows by gravity to three 6-compartment zinc boxes, each compartment of which is 24 x 24 x 24 in., filled with zinc shavings, which are cut in the mill.

The barren solution flows to the 12 x 18-ft. sump tank previously mentioned. The precipitate is handled in a 4-ft. diameter by 3-ft. deep

cleanup tank, served by a 2 x 3-in. Aldrich triplex pump and the precipitate is then dried in a steel plate dry pan 24 in. wide by 40 in. long, heated by steam, and is finally smelted to bullion in a No. 60 Steele-Harvey tilting furnace fired by kerosene.

Every tank in the mill is of steel plate and besides those enumerated there is a water tank on the roll bench 10 ft. diameter by 22 ft. high a duplicate of the solution tank. The only use for water in the mill is for flushing the cake from the hopper of the filter to the tailing dump down the branch.

The circulating solution in the mill is 1.2 lb. KCN and the alkalinity about 2 lb. CaO per ton. No lead salts are used.

The mill is driven by its own engine of the Reliance-Corliss type, 12 x 36-in. stroke, running 150 r.p.m. with steam at 100-lb. at the throttle A Wheeler 300-sq. ft. surface condenser, with combined air and circulating pump under a grating in the engine-room floor, gives 25 to 27 in. vacuum and the engine with maximum mill load indicated 93.7 hp. The flywheel of this engine is 10 ft. in diameter, has a square cross-section and weighs 7,500 lbs. In the engine-room and driven from the main shaft by a friction clutch cutoff pulley is a 10-kw., 120-volt, direct-current generator, running at 1,150 r.p.m., which furnishes lights for the entire job—mill, surface, houses and underground stations. A model switchboard of black slate, 32 x 54 in., is furnished with a voltmeter and ammeter, ground detectors, rheostatt, main switch and eight current switches.

Details of Construction

The framing of the mill is of oak, not because oak had any special advantage, rather the other way, but because it was the only timber available. This was secured at prices ranging from $12 to $15 per thousand feet at the mills, and the hauling thence to the plant cost from $3 to $5, depending upon the mill from which it was hauled, the weather conditions, etc. The roofing was No. 24-gage galvanized corrugated and the siding was No. 26, and averaged in cost $3.70 per square. This light weight corrugated is plenty heavy enough for the favorable climatic conditions here.

All retaining walls and machinery foundations and mill floors were of concrete, mixed in the proportion of one of cement, three of sand and six of rock. Cement costs $2 per bbl., f.o.b. Candor. The rock was taken from the mine waste dump and the sand was secured nearby

at a sole cost of shoveling and hauling. The concrete was placed at $7.50 per yard and could have been put in at a less cost except for some adverse labor conditions obtaining at that time. A total of 336.3 yds. was poured as follows:

	Cubic Yards
Building and retaining walls	126.3
Steel ore bin foundation	11.0
Column pedestals	4.1
Tube mill foundation	13.6
Corliss engine foundation	35.5
Outboard bearing foundation	10.8
Condenser pit walls and floor	9.5
Condenser pier	0.6
Rolls foundation	8.9
Elevator pit walls and floor	7.7
Surface bottom of mill bin	0.2
Crusher foundation	5.1
Conveyor pit, walls, and floor	13.6
Crusher engine foundation	2.6
Line shaft pedestals	5.2
Generator foundation	1.2
Wheel pit mould	0.3
Crusher outboard bearing	0.7
Pedestals for storage tank	2.5
Agitator pedestals	7.3
Buckstay footings for new boilers	0.3
Kelly filter foundation	8.1
Thickener pedestals	4.3
Pump foundations	2.5
All floors, 4 in. thick	56.5

Cost of Mill

The total estimated cost of the mill was $45,000, and the mill was built complete for $42,796.48, distributed as follows:

Summary of Cost of Mill.

Concrete walls and foundation	$	1,962.12
Engineering		2,658.85
New boiler house addition		135.33
Foundation bolts and sundries		67.34
Boiler settings		637.92
Mill lumber and timber		1,237.07
Mill construction, sundry materials		1,627.86
Mill pipe line		1,067.51
Mill general expense		875.01
Mill labor		7,788.62
Mill excavation supplies		3.30
Freight on machinery		1,916.73
Machinery erection, superintendency		340.48
Mill wiring		4.09
	$	20,322.23
Machinery contract		22,893.00
Machinery sundries on open account		657.82
	$	43,873.05
Credit masons included in both items "Boiler setting" and "Labor"		144.90
Compressor foundation at $7.50 per yard		76.00
Compressor excavation		4.90
Compressor hauling		26.65
Compressor installing		71.54
	$	323.99
	$	43,549.06
Total credit from machinery contractor, account extras		752.58
Final total cost of mill	$	42,796.48

The distribution of the labor item in the above summary is given below:

Removing bin at old mill	$	52.21
Building temporary stable		12.27
Moving dwellings from mill site		37.96
Building garage		30.25
Taking down part of old mill		53.16
Grading mill site		511.02
Grading boiler house site		44.21
Grading crusher house site		22.56
Foundations		974.13
Framing and erecting crusher bin		87.07
Framing and erecting crusher and conveyor plant		327.33
Framing and erecting main mill		1,116.68
Hauling lumber		290.32
Hauling corrugated, castings, pebbles, pipe, windows, etc		31.20
Hauling brick for boiler setting		79.27
Hauling fire clay, sand, and lime for boiler setting		51.30
Hauling fixtures and stacks		24.58
Moving small boiler and stack		25.12
Hauling boilers, including unloading and placing		77.50
Connecting and raising stacks		28.47
Laying brick work of boiler settings		222.39
Connecting boilers		4.70
Building boiler house extension		65.02
Hauling mill machinery		298.58
Hauling new compressor		26.65
Installing compressor		71.54
Excavations for compressor		4.90
Repairing and raising dam at cooling pond		49.81
Building launder from condenser discharge to cooling pond, 500 ft		152.33
Building ore trestle, shaft to crusher bin		102.93
Installing mill machinery		727.04
Erecting steel ore bin		32.14
Erecting agitators		101.68
Erecting mill tanks		808.23
Installing pond pump and supply tank		172.11
Main steam line		196.12
Mill piping		121.73
Wiring		9.49
General surface labor and teaming throughout period		612.03
Labor for contractors' account		142.59
Total	$	7,788 62

Labor conditions were very unfavorable. In the first place the labor was inexperienced on construction, and secondly, it was composed more or less of farm hands. Laborers received $1.50 for 10 hours; carpenters, $2 to $3; mechanics, $2 to $2.50. All tank erection and riveting was done by men instructed here, who had never done any of this work before.

On a basis of a 300-day year and 50 tons per day, the mill cost $2.85 per ton of annual capacity.

Production

In the following table there is given the production of gold and silver by counties, 1913 to 1917, inclusive, which will illustrate the distribution of gold produced throughout the State:

PRODUCTION OF GOLD AND SILVER IN NORTH CAROLINA DURING 1913, 1914, 1915, 1916 AND 1917, BY COUNTIES.

County	1913			1914			1915			1916			1917		
	Gold	Silver	Total	Gold	Silver	Total	Gold	Silver	Total	Gold	Silver	Total	Gold	Silver	Total
Anson	$	$	$	$ 15	$ 1	$ 16	$	$	$	$	$	$	$	$	$
Ashe													187	25	212
Burke	1,200	5	1,205	725	3	728	300	2	302	100	25	125	500	40	540
Cabarrus	548		548	22		22	281	1	282	200	162	362	700	50	750
Caldwell	210	2	212	600	3	603	150	1	151	100		100	300	25	325
Catawba	250	1	251				553	2	555	300		300			
Davidson													1,200	600	1,800
Gaston	155		155				200	1	201						
Granville							7,341	51	7,392	2,000	10	2,010	100		100
Guilford							8,440	30	8,470	170	5	175	500	5	505
Iredell	210	1	211										100	5	105
McDowell	477	2	479	2,000	6	2,006							300		300
Mecklenburg	496	2	498	2,000	24	2,024	725	2	727	300		300	300		300
Montgomery	116,000	758	116,758	85,010	543	85,553	90,324	409	90,733	4,408	25	4,433	2,000	100	2,100
Randolph	2,194	300	2,494	50	1	51							800		800
Rowan	1,079	8	1,087	34,519	227	34,746	45,864	110	45,974	600	52	652			
Rutherford	629	5	634	3,091	6	3,097	5,694	13	6,707	5,820	2	5,822	1,500	25	1,525
Stanly				22		22	4,129	51	4,180	1,300	3	1,303	800	10	810
Union	3,000	11	3,011	3,087	30	3,117	8,000	70	8,070	10,939	152	11,091	3,000	30	3,030
Totals	126,448	1,095	127,543	131,141	844	131,985	172,001	743	173,744	26,237	436	26,673	12,287	915	13,202

The next table gives the value of the gold and silver produced in North Carolina from 1882 to 1917 inclusive:

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1882 TO 1917.*

Year	Gold	Silver	Total
1882	$ 190,000	$ 25,000	$ 215,000
1883	167,000	3,000	170,000
1884	157,000	3,500	160,500
1885	152,000	3,000	155,000
1886	175,000	3,000	178,000
1887	225,000	5,000	230,000
1888	136,000	3,500	139,500
1889	145,000	3,878	148,878
1890	118,500	7,757	126,257
1891	95,000	6,465	101,465
1892	78,560	12,671	91,231
1893	53,600	17,325	70,925
1894	46,594	455	47,049
1895	54,200	520	54,720
1896	44,300	646	44,946
1897	34,600	388	34,988
1898	84,000	905	84,905
1899	34,500	388	34,888
1900	44,653	15,986	60,639
1901	60,410	34,023	94,433
1902	93,650	30,212	123,862
1903	113,604	16,907	130,511
1904	123,924	19,133	143,057
1905	129,153	20,216	149,369
1906	122,008	30,944	152,952
1907	82,195	14,299	96,494
1908	97,495	668	98,163
1909	43,075	324	43,399
1910	68,586	4,888	73,474
1911	70,282	500	70,782
1912	166,014	2,985	168,999
1913	126,448	1,095	127,543
1914	131,141	843	131,984
1915	172,001	743	172,744
1916	26,237	436	26,673
1917	12,187	915	13,102

*Coining value.

Producers and Owners of Mines

The following is a list of companies and individuals who have been or are possible producers of gold and silver in North Carolina:

F. C. Abbott & Co., Charlotte, N. C.....Grier Mine
Dr. Chas. L. Alexander, Charlotte, N. C.....Yellow Dog Mine
James A. Butler, Statesville, N. C.....Butler Mine
Rudisill Gold Mining Co., Charlotte, N. C.....Rudisill Mine
Catawba Gold Mining Co., care Geo. R. Collins, Salisbury, N. C.....Shuford Mine

The Consolidated Sales Mining, Milling and Mfg. Co., care M. Groenendyke, Charlotte, N. C.
A. M. Cox, Georgeville, N. C.....Garmon Mine
Thos. J. Dolan, 112 N. Broad St., Philadelphia, Pa.....Argo Mine, Nash County
El Orox Mining Co., Hemp, N. C.....Clegg Mine
Eureka Mining Co., High Point, N. C.....Hoover Mine, Guilford County
Sedbury Mine, Montgomery County
J. W. Fleming, Lenoir, N. C., R. 5.....Fleming Mine
Gross Dixon Mining Co., Cana, N. C., R. 2.
John A. Hodgin, Greensboro, N. C.....Hill Mining Tract
Howie Mining Co., 763 Calvert Bldg., Baltimore, Md.....Howie Mine
John F. Jones, Blacksburg, S. C.....Jackson Mine
Martha Washington Mining Co., Candor, N. C.
A. C. Mauney, Salisbury, N. C.....Rumpler Mine
Mogul Mining Co., Matthews, N. C., R. 26.....Davis Mine
John J. Peters, Linwood, N. C., R. 2.....Cross Mine
Pioneer Gold Mining Co., Concord, N. C.....Pioneer Mine
W. S. Proctor, Candler, N. C.
Rich Cog Mining Co., Eldorado, N. C.....Rich Cog Mine
T. A. M. Stevenson, 655 W. 4th St., Winston-Salem, N. C..Silver Hill Mine
W. E. Sudlow, Golden, N. C.
Surface Hill Mining & Milling Co., Charlotte, N. C.

COPPER

Copper mining in North Carolina ceased entirely in 1913, but there was a revival of it in 1914, with a small production from the Cullowhee mine in Jackson County. There was a small production in 1914 from the Blue Wing district; in 1915 there were productions from the Copper King district of Granville County, the Gardner Hill mine of Guilford County, and the Gold Hill district of Rowan County. In 1916 there was a small production of copper from the Virgilina district of Granville and Person counties and the Gold Hill district of Rowan County.

During 1913 operations were suspended on the Cullowhee copper mine, and matte furnaces near Webster, Jackson County. One car of slag and copper bottoms from the old Ore Knob mine in Ashe County was shipped by J. P. Labaw to the United States Metals Refining Company at Chrome, New Jersey. This car of 72,739 pounds contained the following:

Gold	12.904	ounces
Silver	112.11	ounces
Copper	14,672.	pounds

The copper produced in 1915 was derived from concentrates produced from 4,438 tons of ore mined in Granville, Guilford and Rowan counties, which yielded approximately 4 pounds of copper per ton of ore concentrated.

In 1916 the copper was derived from ore mined in Granville and Rowan counties which yielded approximately 59 pounds of copper per ton. The Ore Knob mine in Ashe County was under development in 1916 and it is said that a flotation plant to treat the copper ores would be installed.

The Copper King mine now being operated by the Tenvanoca Copper Company is situated in Person County, 3 miles south of Virgilina, Va. In 1917 it was reported that the property was taken over by Fisher and Corozza Brothers Company, of Baltimore, under option lease. They have added considerable equipment, including large ore bins, and are erecting a 60-ton unit smelter on the property.

It is reported that work was carried on during 1917 on the Durgy mine, Person County, located 8 miles south of Virgilina, Va., and formerly owned by the Person Consolidated Copper and Gold Mining Company. The main shaft has reached the 525-foot depth and levels cut out at 515 feet. Extensive work has been done on the 415 and 340-foot levels. The property is in running condition, and the underground works are being kept unwatered. Shrinkage method of stopage is being used. There has been installed a complete steam, air and electric equipment. It is expected that the property would be actively worked during 1918.

It is also reported that the Copper King mine in Person County, and Gardner Hill mine in Guilford County have been taken over by Baltimore interests and that a 50-ton smelter to handle the ores from all of these properties is being built at Virgilina, Va.

Production

In the table below there is given the production of copper ore and the amount and value of copper obtained from this for the years 1900 to 1917, inclusive:

PRODUCTION OF COPPER FROM 1900 TO 1917, INCLUSIVE.

Year	Crude Ore Mined	Copper Produced	Value
	Tons	*Pounds*	
1900	6,948		$ 41,600
1901	10,398	512,666	76,900
1902	16,741	1,417,020	212,553
1903	4,106	458,133	67,037
1904	4,250	305,000	36,600
1905	10,000	488,888	88,000
1906	11,729	703,775	135,829
1907	11,011	597,878	116,416
1908	180	19,393	2,560
1909	3,575	224,512	29,186
1910	2,221	140,514	17,845
1911			
1912	500	63,766	10,521
1913			
1914	408	20,434	2,718
1915	4,438	17,170	3,005
1916	166	9,800	2,411
1917	1,249	124,991	34,123

Owners and Operators of Copper Properties in 1917

Eli Brady, Prosperity, Moore County, N. C.

Southern Minerals Co., Ore Knob, N. C.

Cullowhee Mining and Reduction Co., Cullowhee, N. C.

Gold Hill Consolidated Co., Gold Hill, N. C.

W. N. Kidd, Highfalls, N. C.

R. G. Lassiter, Virgilina, Va. (Person and Granville counties).

D. S. Lindsay, Judson, N. C., R. F. D.

S. Talbert McKinney, 18 Broadway, New York, N. Y., Gold Hill, N. C.

Fisher and Corozza Bros. Co., 416 Equitable Bldg., Baltimore, Md. (Person and Granville counties).

Sig. H. Rosenblatt, 18 Broadway, New York, N. Y., Gold Hill, N. C.

Watauga Copper Co., Eulalie, Macon County, N. C.

LEAD AND ZINC

The only lead and zinc deposits of importance in North Carolina are those in the Silver Hill or Cid district in Davidson County, which are described in Bulletin 22 of the publications of the North Carolina Geological and Economic Survey. The first ore mined was lead carbonate

containing disseminated plates of native silver. Sulphide ores were soon reached, and the later history of the mine is concerned largely with repeated dumps to handle the mixed sulphide or constituent of galena, sphalerite, chalcopyrite, and pyrite, and containing about 20 per cent lead, 40 per cent zinc, 0.5 per cent copper, 9 per cent iron, and some gold and silver. The total depth of the mine worked, as reported in 1915, is 725 feet on the vein ore 570 feet vertical. One car load of 40 per cent zinc concentrates, resulting from the work of earlier years, was shipped from this mine in January, 1913. There were no productions in 1914, 1915 and 1916; but in 1917 a small quantity of lead was marketed which came largely from the dumps of the Silver Hill mine.

Mr. T. A. M. Stevenson, of Winston-Salem, owner of the Silver Hill mine, reports that Mr. H. M. Baker is working the dump ore of this mine by a flotation process; that the Atlantic Ore and Alloy Company is working the slag dump, and that he (Mr. Stevenson) is prospecting with a core drill. No ore was shipped on account of the embargo.

"The Silver Valley mine, a few miles northeast of Silver Hill, has similar mixed sulphide ore. This mine was worked to a depth of 210 feet in the early eighties, but has had no recent output. Difficulties of concentration seem to have been the trouble at this mine. The successful work of mixed sulphide ores elsewhere and the recent opening of mines of zinc ore mixed with other sulphides in New York and Virginia, suggest the possibility that these mines in North Carolina may yet make important contributions to the zinc output of the United States."*

Production

There is given in the following table the production of lead and zinc in North Carolina from 1912 to 1917, inclusive:

PRODUCTION OF LEAD AND ZINC IN NORTH CAROLINA
1912—1917, INCLUSIVE.

Year	Lead—Pounds	Zinc—Pounds	Total Value
1912	92,000	283,320	$ 25,694
1913	----------	20,400	1,142
1914	----------	----------	----------
1915	----------	----------	----------
1916	----------	----------	----------
1917	2,583	----------	222

*C. E. Siebenthal, "Zinc and Cadmium in 1915" Min. Res. of U. S., 1915, Part I, page 871.

IRON

The iron ores of North Carolina are widely distributed throughout the State and include magnetite (the magnetic oxide of iron); hematite (the red oxide); limonite (the yellow oxide); and bog iron ores. Siderite or spathic iron occurs sparingly at a number of mines.

Up to the outbreak of the world war, the low prices of iron have made mining in a great many of the North Carolina localities unprofitable. As the demand for iron grew, however, in 1914 to 1917, a number of hematite deposits were opened in Madison and Cherokee counties which had not been worked for many years, and some of which had never been mined.

The history of iron mining in North Carolina dates back to as early as 1729, when small shipments of iron were made to England. Probably the first ore mined was the bog ores near the coast. Mining for iron almost kept pace with the settlement of the western portion of the State, and the remains of many of the old workings are still visible.

Some of the principal iron localities are: The magnetite ores of Granville, Stokes, Surry, Catawba, Ashe and Avery counties; the limonite ores of Chatham, Gaston, Madison and Cherokee counties; and the hematite ores of Granville County. Geologically, the magnetites and hematites are confined almost exclusively to the crystalline rocks. Some limonites are also found in these rocks, as well as in the Ocoee formation of Madison and Cherokee counties. Limonite ores (bog iron ores) are also found in the more recent formations of the Coastal Plain region.

The most noted iron mine in the State is the magnetite iron mine at Cranberry, Avery County, which has been worked continuously since 1876. This ore was first worked in a small way in Catalan forges as early as 1820, and the quality of the iron made soon became known and attracted a great deal of attention throughout the East. The ore body consists of an immense lens of magnetite which has associated with it hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. There is undoubtedly a large quantity of this type of ore in the Cranberry district, and the deposits are adapted to pig iron at a low cost.

Similar deposits of magnetic iron occur in Ashe County which were operated on a small scale as early as 1802. These deposits are located in the northeastern part of Ashe, principally along the north fork of the New River and its tributaries. These deposits are described in some detail in Economic Paper No. 34 of the North Carolina Geological and Economic Survey, pages 65-72.

Brown Hematite (Limonite) Ores

The brown hematite (limonite) deposits of Cherokee County are among the most important in the State. The ores were worked in forges as far back as 1840 and supplied the surrounding country with bar iron for local uses. Since 1888, however, none of these forges have been in operation. Because of the great demand for iron brought about by the war, there was great activity in this iron region during 1917, and a number of companies and individuals are working these deposits in Cherokee County, principally in the vicinity of Andrews, Marble and Murphy.

Other valuable deposits of brown hematite are located at Wilson's Mills,* Johnston County; at Shut-In Creek, Madison County; and at Ore Hill, Chatham County.

In the summer of 1917, Mr. John E. Smith, Geologist of the Geological Department of the State University, made a brief survey of the brown hematite deposits of Madison and Cherokee counties, with the following results:

"*Madison County.* Mine owned by Anson G. Betts Company of Asheville, and is located about four miles southwest of Hot Springs, 1½ miles from mouth of Shut-In Creek. The plant is on the creek and the ore extends westward along the hillside to the summit about two miles distant. Ore occurs along and near the contact between a conglomerate and a limestone of Cambrian age, some of it being residual in the clay.

"The mines are one-half to 1 mile from the plant and were reached from it by two tramways. The ore was all worked from open cuts except the last attempt, in which the hydraulic process was used. This was about 300 yards from the plant and the water and ore were carried to the plant by means of an open box flume. The water was piped from up the creek to a tank at the plant by gravity and then pumped to supply a hydraulic stream at the mine.

"The equipment consists of three boilers; one centrifugal 6-inch pump; one 3-inch steam pump; one 2-inch steam pump; one steam locomotive, 28 tons; one gasoline locomotive, 3 tons; 20 dump cars of 1 yard capacity; and 1½ miles of track between the plant and the railroad. The concentration of the ore is accomplished by means of the log roller process, the ore being moved by gravity as it passes through the plant, capacity 125 to 300 tons daily.

"In all, there were six mines opened on this property, from which about 30,000 tons of ore have been taken, half of this by the Betts Company. At first the cost was $1.00 to $1.25 per ton, but later was reduced 25 per cent or more by careful management. Their dump cars have been removed to Cherokee County; also tracks, except that between the plant and railroad. Operation ceased July 15, 1917.

*See Economic Paper No. 8, "The Mining Industry in North Carolina during 1903," page 23.

"*Cherokee County.* Fain Iron Works, ¾ miles southwest of Murphy, were leased by Anson G. Betts Company. The vein is a brown iron ore extending N. 50° E., is nearly vertical—15 to 50 feet wide—averaging nearly 30 feet maximum depth; worked 50 feet; vein much deeper; has been proved for ½ mile. Ore is worked by blasting, with pick and shovel, and is carried by dump cars of 1½ tons capacity. It is moved by gravity along 2,200 feet of track (4 per cent grade) to L. & N. siding, ½ mile from Murphy. The empty cars are drawn back by mules. This ore is loaded without screening or washing and there is no waste in stripping on top.

"About 12 men were employed (summer 1917) at $1.85 per day and 500 to 600 tons per week were shipped to Middlesboro, Ky., and LaFollette, Tenn. This ore ranges from 44.75 to 49.5 per cent iron; is mined at a cost of 45c to 48c per ton; and sells for $2.60, f. o. b. cars at Murphy. The freight rate is about $1.00 per ton. Operations were begun here in April, 1917, and about 7,000 tons have been produced since that time.

"The Wells property is 2 miles east of Murphy and is owned by Anson G. Betts & Company. The vein is 3 to 8 feet wide; is nearly vertical, and is a solid black-brown ore, extending for ½ mile. Only the black ore was used, it being dug out of a low grade (35 per cent) ocherous ore. This deposit was worked for about 2 months and closed July 1, 1917, after producing more than 1,000 tons.

"The Dockery place is 6 miles east of Murphy at Montvale. The ore vein here is made up of flat lenses stacked one on another and reaching a maximum of seven layers, width 1 to 8 feet; dip about 45°. This was worked for about 3 months and produced about 3,000 tons.

"The Kinsey property joins the Dockery place and the ore lies in the same formation. About 7,000 tons have been produced since the first opening of this mine some years ago, 1,200 of which was mined this year.

"The J. M. Kilkpatrick property (worked by Betts & Company) joins the Kinsey place on the east, 7 miles from Murphy. Here the vein is 20 feet wide, vertical and cut into two parts by a "horse." The ore is more solid than that on the Kinsey property and has been proved for nearly one-half mile. It has been traced through the property of Mr. Welch and J. Green for half a mile further. It has produced 1,000 tons recently.

"The Puett property at Marble, Cherokee County, joins the property of W. McHan on the south and is worked in connection with it by Betts & Company. The two have produced 1,200 to 1,500 tons during the last six months. Some carloads of this ore are reported to have produced 56 per cent iron. No screening or washing was done in concentrating the ore. The Company pays Mr. McHan a royalty of 10 per cent per ton.

"W. McHan at Marble, N. C., began in January, 1917, to mine brown iron ore. The work was done by contract until April, when he took charge of it himself. The ore was worked without screening or washing and averaged 45 per cent iron. It was sold at the rate of $3.00 for 50 per cent ore f. o. b. cars at LaFollette, Tennessee. Exclusive of hauling and loading on the cars, the cost was $1.35 per ton at the mine. About 900 tons were produced and work was discontinued about July 1, 1917. One car of this ore tested gave 2 per cent manganese, and another showed 3 per cent manganese. The ore occurred in veins 3 to 10 feet wide and was worked in open cuts. Three pits were opened at a distance of one-half mile from the station.

"On the Cooper place, one-half mile from Marble, N. C., Betts & Company operated an iron mine producing ore 48 per cent to 49 per cent iron. At first the cost was $2.20 per ton, but this was reduced to $1.18 by expert management. About 3,000 tons of ore have been shipped from here and the company have obtained the mineral rights on 150 acres.

"On the Whittier property, 3 miles south of Andrews, is the Cover and Porter's iron mine. They own mineral rights on 201 acres, and began mining May 1, 1917. After shipping 1,000 tons to LaFollette, Tennessee, they installed 1 mile of 4-inch iron pipe and began hydraulic iron mining with the level of the pit but a few feet above the bottom of the valley of the branch of the Tatham Creek, near which the mine is located. The first opening was made several hundred yards from the present pit and higher on the hill. The ore has been proved through a distance of half a mile along the lower slope of the hill and the present pit is about one-third of the distance from the south end of the ore. Ten men are employed in the pit at $1.75 to $2.00 per day and 8 teams haul the ore a half mile to a siding on the Nantahala (Lumber) Railroad. They are loading 2 cars daily at a cost of 70c to 80c per ton, including the expense of mining. The ore is sold to the Virginia Iron, Coal and Coke Company of Middlesboro, Kentucky. This ore sometimes runs 55 per cent or 56 per cent, but averages about 51 per cent to 52 per cent. At first the ore was hauled 3 miles to Andrews and loaded on cars at a total cost of $1.25 per ton. The water piped has a head of 130 feet, which gives it great force in the pit. The nozzle is arranged on a swivel so that the stream can be played upon the ore in a complete circle if necessary."

THE TITANIFEROUS IRON ORES*

"Titaniferous magnetites occur at a number of localities in the Piedmont and Appalachian regions of North Carolina, but no deposits of great promise are known. The rocks of this western half of the State consist principally of a complex of gneisses, ranging from acidic or granitic gneisses to very basic rocks, as hornblende gneisses, granites, and other igneous rocks. The most recent and complete account of the titaniferous magnetites occurring in this region is contained in the bulletin on the iron ores of the State by Nitze.[1] This report includes all information in previous reports of the State survey, and, except for data relative to the localities visited by the author of this report, it forms the basis of the following account.

"As most of the localities cited in the North Carolina reports show no evidence of the existence of deposits of any importance, it was considered useless to attempt to visit all, and at the suggestion of Dr. J. H. Pratt, State Geologist of North Carolina, the author visited what were

*Taken from Bulletin 64 of the Publications of the Bureau of Mines on "The Titaniferous Iron Ores in the United States—Their Composition and Economic Value," by Joseph T. Singewald, Jr., pages 80-93, inclusive. Published in 1913.

[1]Nitze, H. B. C., A preliminary report on the iron ores of North Carolina: North Carolina Geol. Survey Bulletin 1, 1893.

considered the two most promising areas, the belt extending across Rockingham, Guilford, and Davidson counties, just west of Greensboro, and the area to the north of Lenoir, in Caldwell County.

"The general distribution and character of the ores is very briefly indicated; a more detailed description is given only of the two areas visited by the writer.

Distribution and Character of the Ores

"References to the character of the immediate country rock of the ores are very meager and of a most general nature. All that can be gotten from the literature is that it is in most cases a schistose femic rock. No information as to what the original rock might have been is given. Little can be said, therefore, in regard to the geology of the ores.

"Our knowledge of the character and extent of the ores is more complete, as a large number of analyses have been made, and some data are given indicating the size of the ore bodies. The table following gives the available analyses, arranged alphabetically by counties. It is the same as that given by Nitze,[2] with five analyses added in Guilford County taken from Lesley.[3]

[2]Op. cit., pp. 229-231.
[3]Lesley, J. P., Notes on the titaniferous iron belt near Greensboro, N. C., Proc. Am. Phil. Soc., Vol. 12, 1871, pp. 154-156.

RESULTS OF ANALYSES OF NORTH CAROLINA ORES.

Source of Ore	SiO_2	Fe	Mn	S	P	TiO_2	Cr_2O_3	Al_2O_3	$CaCO_3$	MgCO	CaO	MgO
ALLEGHANY COUNTY—	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1. Fielden Carrico, Old Forge workings	6.20	54.72		0.038	0.047	4.86						
ASHE COUNTY—												
2. Cicero Pennington, Wallens Creek	4.75	52.23		.112	.021	8.91	1.19					
3. Cicero Pennington, Wallens Creek	4.72	52.44		.077	.004	5.38						
4. Cicero Pennington, Wallens Creek	5.07	52.45			.022	9.11						
5. Bauguess opening, near Little Helton Creek	6.35	57.66		.061	.008	4.69	.505					
6. Bauguess opening, near Little Helton Creek	7.91	53.35		.078	.022	4.92						
7. G. C. McCarter, Little Helton Creek	9.90	46.81		.137	.025	6.03	.63					
8. G. C. McCarter, Little Helton Creek	10.92	40.71		.065	.012	5.54						
9. G. C. McCarter, Shipps Branch opening	5.37	51.75			.018	9.17						
10. William Young, Little Helton Creek	5.12	50.77		.04	.005	4.95						
11. William Young, Little Helton Creek	4.35	52.85			.013	8.80						
CALDWELL COUNTY—												
12. J. K. Farthing, Warrior Creek	6.50	31.92	0.39	.058	.025	2.40			7.48	15.64		
13. Joshua Curtis, Yadkin River (average)	6.63	36.00	1.09	.021	.060	14.90			7.37	16.08		
14. Joshua Curtis, Yadkin River (selected)	7.55	28.24		.013	.140	41.21						
15. Joshua Curtis, Yadkin River		37.10			Trace	36.40						
16. Joshua Curtis, Yadkin River		25.76			.076	38.81						
CATAWBA COUNTY—												
17. Forney ore bank, near Maiden Station	1.41	67.92		.07	.025	1.60						
DAVIDSON COUNTY—												
18. K. R. Swain, Massive ore	.76	57.68				13.52	.46	1.68				
19. K. R. Swain, Micaceous ore	5.68	52.68				11.67	.48	5.08				
DAVIE COUNTY—												
20. Kelley-Lefler place, 5 miles south of Mocksville	.778	60.00		.033	.008	10.32						
21. Allen place, 7 miles northeast of Mocksville	5.50	52.80		.11	.02	8.00						
GUILFORD COUNTY—												
22. Elisha Charles	.40	59.03				11.95	1.07	1.06				
23. Widow Cook	1.84	56.21				13.28	.65	2.30				
24. John Clark	1.30	56.41				12.35	1.10	2.54				
25. Sargeant Shaft	1.31	55.06				13.60	.72	4.26				
26. Sargeant Shaft		53.20			.005	Present						
27. Sargeant Shaft	12.86	53.27				13.58						
28. Mrs. McCuiston, soft Micaceous		43.47				16.06						
29. Mrs. McCuiston, soft micaceous	12.75	41.95				15.35	1.25	5.17				
30. Mrs. McCuiston, Magnetic part of above	1.30	67.60				1.27	1.43	.55				

RESULTS OF ANALYSES OF NORTH CAROLINA ORES—CONTINUED.

Source of Ore	SiO_2	Fe	Mn	S	P	TiO_2	Cr_2O_3	Al_2O_3	$CaCO_3$	$MgCO_3$	CaO	MgO
GUILFORD COUNTY—*Continued.*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
31. Mrs. McCuiston, Nonmagnetic part of above	26.80	21.63	-------	-------	-------	16.20	.43	8.87	-------	-------	-------	-------
32. Mrs. McCuiston, massive ore	-------	33.97	-------	-------	-------	2.63	-------	-------	-------	-------	-------	-------
33. W. A. Lewis	.50	57.32	-------	-------	-------	12.27	.57	3.62	-------	-------	-------	-------
34. Belt, west of Greensboro (*a*)	.75	57.77	.22	-------	-------	12.08	.32	4.62	-------	-------	0.13	2.04
35. Belt, west of Greensboro	1.89	59.95	.32	-------	-------	8.72	.40	3.93	-------	-------	.17	1.36
36. Belt, west of Greensboro	1.04	58.52	Trace	Trace	.00	12.32	Trace	3.87	-------	-------	.64	.49
37. Belt, west of Greensboro	1.50	60.41	.08	.00	Trace	8.65	.83	2.90	-------	-------	.75	2.02
38. Belt, west of Greensboro	.52	57.30	.48	.00	.00	13.74	Trace	4.50	-------	-------	.72	.54
LINCOLN COUNTY—												
39. Lawson Bess, Indian Creek	11.37	56.95	-------	.045	.029	2.40	-------	-------	-------	-------	-------	-------
MACON COUNTY—												
40. Felix Kilpatrick, 5 miles east of Franklin	.77	54.24	-------	.04	.013	17.60	-------	-------	-------	-------	-------	-------
41. Alex. Waldrop, 6 Wiles west of Franklin	11.91	20.64	.69	.089	.016	3.20	-------	-------	3.31	14.69	-------	-------
MADISON COUNTY—												
42. Road, midway between Asheville and Burnsville	.83	36.26	.63	.09	Trace	37.88	-------	9.51	-------	-------	-------	-------
43. John Brigman, Paint Fork	*	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
44. Swan Woody, Spring Creek	2.37	62.16	-------	.026	.014	7.44	-------	-------	-------	-------	-------	-------
MITCHELL COUNTY—												
45. Avery land, Roaring Creek Yellow Mountain	1.46	65.32	-------	.025	.009	4.80	-------	-------	-------	-------	-------	-------
46. Avery land, Roaring Creek, Yellow Mountain	.54	66.95	-------	None	.015	6.80	-------	-------	-------	-------	-------	-------
47. Parker place, 2 miles west of Burnsville	1.22	57.98	-------	.015	.041	4.56	-------	-------	-------	-------	-------	-------
48. Joel Gouge, mouth of Little Rock Creek	1.13	64.56	-------	.027	.078	4.48	-------	-------	-------	-------	-------	-------
49. Above Jenkins mine, Greasy Creek	6.58	54.48	-------	.023	.033	4.96	-------	-------	-------	-------	-------	-------
ROCKINGHAM COUNTY—												
50. Levi Shaw	1.80	54.17	.96	-------	-------	14.46	.97	2.66	-------	-------	-------	-------
51. P. Hopkins	.74	55.61	.82	-------	-------	13.92	1.07	3.82	-------	-------	-------	-------
52 Granular reddish ore	1.39	30.97	.63	-------	-------	.78	.30	52.24	-------	-------	-------	-------
53. Granular grayish ore	.98	33.52	.80	-------	-------	2.42	Trace	44.86	-------	-------	-------	-------
54. Dannemora mine	4.71	48.41	-------	.089	.023	13.74	.34	8.68	-------	-------	-------	-------
55. Dannemora mine, fine ore	-------	49.41	Trace	-------	.001	Present	-------	-------	-------	-------	-------	-------
YANCEY COUNTY—												
56. Mine Fork, 6 miles north of Burnsville	9.25	39.42	-------	.12	.011	11.90	-------	-------	-------	-------	-------	-------
57. Jerry Ferguson, 9 miles west of Burnsville	23.38	39.00	-------	-------	-------	2.56	-------	-------	-------	-------	-------	-------

*a*Ore represented by this analysis had a trace of V_2O_5. *Titanic acid present in large quanity.

"These analyses show a considerable range in TiO_2 content; whereas a number carry only a small percentage of TiO_2, others have such a high percentage that the ore must consist almost entirely of ilmenite. The phosphorus ratio in nearly all of the ores is below the Bessemer limit, and sulphur is low. The percentage of iron is also high in most of the analyses. Except for their titanium content, most of the ores would be classed as medium to high grade.

Alleghany County

"A zone of hornblende schists, in many places altered to steatite or soapstone, and carrying crystalline grains of magnetite, usually titaniferous, extends across Alleghany County parallel to the Little River and usually on the south side of it. Locally the magnetite becomes more abundant in the schists and may be sufficiently concentrated to form small lenses of ore. On the farm of Fielden Carrico, near the State line, several such ore bodies were opened up about 30 years ago to supply a near-by forge in Virginia (see analysis 1). These openings have long since been abandoned and caved in.

Ashe County

"A belt of titaniferous magnetite extends in a northeasterly direction from Helton Creek, near Sturgill, to Little Helton Creek, a distance of 2½ miles. The analyses of the ores in this belt (analyses 2 to 10) show a moderate titanium content.

"At the northeast end of the belt is a series of outcrops, one of which shows an ore bed at least 25 feet wide. It is a coarse granular magnetite practically free from gangue. The country rock is in part a prophyllite schist and in part a hornblende rock altering to asbestos. South of these outcrops is another showing 5 feet of ore with a gangue of epidote, feldspar, and quartz. At the southwest end of the belt are several more outcrops, in which the width of the ore ranges from 8 to 15 feet. The ore is a fine-grained magnetite with a gangue of hornblende and epidote.

Caldwell County

"Two localities in this county were visited by the writer, but neither showed either large or promising deposits.

Richlands Cove Deposit

"Sixteen miles north of Lenoir in what is known as the Richlands Cove is a body of titaniferous iron ore on the east bank of the Yadkin River. A small opening has been made adjacent to the river bank

exposing a face about 20 feet high and 40 feet wide. This titaniferous mass occurs within a country rock consisting of sericitic schist. It consists of small particles of ore in a matrix chiefly made up of fibrous and scaly aggregates of chlorite, serpentine, and talc. The individual ore particles average less than one-half mm. in diameter, and rarely exceed 1 mm. They are very slightly magnetic to nonmagnetic. Two polished sections of the ore etched with hydrochloric acid retained their luster and showed no evidence of the intergrowths of ilmenite and magnetite. These facts, together with the high titanium content shown in the analyses in the tables (analyses 13 to 16), indicate that the ore particles consist chiefly of ilmenite. This is further borne out by the fact that the sands along the river close to the deposits contain only nonmagnetic ore particles.

"Just north of the opening on the river bank is a small side valley in which a rock of identical character outcrops. This outcrop is about 300 feet from the river on the north side of the valley.

"Neither of these deposits shows extensive outcrops, and they seem to be only small intercalations in the more acidic country rock. They undoubtedly represent small basic intrusions that have undergone metamorphism with the rest of the region.

"The titanium content is so high that the deposits cannot be regarded as iron ores. As sources of titanium, their inaccessible location and seeming small size are great drawbacks. At present they possess no economic value.

Farthing Deposit

"On the north side of Warrior Creek, 5½ miles north of Lenoir, there are outcrops of an ore bearing rock. The rock consists principally of a green hornblende schist carrying considerable ore disseminated in minute grains and in stringers of nearly pure ore. It occurs as an intercalation in more acidic schistose rocks. Similar rock can be traced for some distance to the southwest by means of surface fragments, but no openings have been made on this occurrence.

"Locally this hornblende rock contains richer portions of fine-grained ore. A thin section of such a piece consisted principally of the ore minerals and spinel. Less abundant were augite and hornblende. The ore grains are less than 0.5 mm. in diameter, and do not constitute more than one-third of the mass. On etching polished surfaces of these ores the small magnetite grains are dissolved out without showing any ilmenite intergrowths, and the polished surfaces of the ilmenite remain unattached. Further evidence that the small pits on the polished surface were occupied by magnetite is the fact that a considerable part of the powdered ore is magnetite. Analysis 12 shows the composition of the ore.

"Adequate exposures to enable one to judge accurately the extent of the occurrence are lacking. The richer parts of the rock are so lean, however, as to preclude any possibility of working the deposit.

Catawba County

"A belt of titaniferous ore extends across parts of Catawba and Lincoln counties, from a point southwest of Newton to about 9 miles west of Lincolnton. At the northeast end is the Forney mine, which formerly supplied several forges in the neighborhood. The ore is a coarse granular magnetite, usually free from gangue, and occurs in irregular pockets a few inches to 3 or 4 feet in thickness. The country rock is called syenite in the North Carolina report. An analysis of the ore (analysis 17) shows a low titanium content. Float ore found in this belt at the southwest end also shows (analysis 39) only a small percentage of titanium.

Davidson County

"See Guilford County.

Davie County

"Titaniferous ores are described at two points in Davie County near Mocksville.

"About five miles south of Mocksville, near the mouth of Bear Creek, is a fair showing of float ore for a distance of 600 feet on the old Maxwell place. Float ore can be traced at intervals for 1½ miles to the southwest to the South Yadkin River. The country rock is described as "hornblende and syenite, with occasional dissemination of magnetite granules." The ore is a medium grain magnetite with little gangue (analysis 20).

"Similar ore occurs 7 miles northeast of Mocksville and one mile east of Kernatzer station. Several pits and a shaft were put down here during the Civil War. The ore was worked in a forge four miles distant on Dutchmen's Creek. Float ore can be traced faintly 200 to 300 yards northeast and southwest of the old shaft (analysis 21).

Guilford County

"A belt or titaniferous magnetite extends across Guilford County in a northeasterly direction, and passes beyond the boundaries of Guilford County into Rockingham County on the northeast and into Davidson County on the southwest. It lies to the north and west of Greensboro. It consists of two parallel subordinate belts known, respectively, as the Tuscarora belt and the Shaw belt, the total length of which is 30 miles.

The longer and more persistent is the Tuscarora belt. The Shaw belt lies several miles northwest of it.

"The area is one of prevailing granites and gneisses within which are smaller bodies of gabbro. Though evidence of the presence of the gabbro is obtained repeatedly along the belt by outcrops and surface fragments, it seems that the belt is not one elongated mass of gabbro, but consists of a number of smaller masses having a linear distribution along the belt. The ore bodies are segregations within these small gabbro masses and do not constitute a continuous body extending the entire length of the belt.

"Surface outcrops of the ore bodies are lacking, and as the old workings have all caved in the character of the ore can be judged only from the surface fragments. A detailed examination of the belt was made by Lesley[1] for a Philadelphia mining company, and trenching was done at a number of points to expose the ore. Dr. Lesley consequently had unusual opportunities for observing the ore bodies, and his account of them is the most valuable we have. Shortly after this the belt was visited by Prof. W. C. Kerr and Dr. F. A. Genth, and described in a report of the North Carolina Geological Survey.[2] The descriptive part is taken mainly from Lesley's report, but 16 additional analyses made by Genth are given. This same report was reprinted with slight alterations in 1883[3] and again in 1893.[4] A brief sketch is also given in the Tenth Census reports.[5]

"It is not surprising that Dr. Lesley at that early date misinterpreted the genesis of the ores. He regarded them as bedded deposits of sedimentary origin, and consequently the conclusions he drew as to the geology and structure of the deposits are erroneous. These are of historical interest only and will not be repeated here. The records of his observations, however, supply facts no longer accessible on account of the filling of the old workings and trenches. The ore bodies consist of strings of lens-shaped masses, continually enlarging and contracting in thickness from a few inches to 6 and 8 feet. 'The principal beds may be safely estimated at an average of 4 feet, and in the best mining localities the average yield of a long gangway may reach 5 feet.' The occurrence of the ore body in a series of disconnected lenses is consequently verified by the observations of Prof. Lesley.

---

[1]Lesley, J. P., Note on the titaniferous iron ore belt near Greensboro, N. C., Proc. Am. Phil. Soc., vol. 12, 1871, pp. 139-156.

[2]Report of the Geological Survey of North Carolina, vol. I, 1875, pp. 236-250.

[3]Kerr, W. C., and Hanna, G. B., Ores of North Carolina: Geol. Survey of North Carolina, 1888, pp. 143-154.

[4]Nitze, H. B. C., A preliminary report on the iron ores of North Carolina: North Carolina Geol. Survey Bull. 1, 1893, pp. 60-68.

[5]Tenth Census, vol. 15, 1886, pp. 308-311.

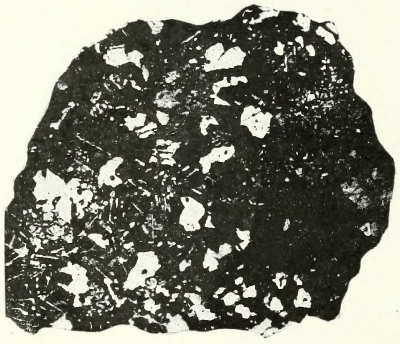


FIG. 1. Tuscarora Mine, N. C., Ore. (× 2.)

Tuscarora Mine

"This mine was worked in the seventies by a Philadelphia mining company. Forges were erected on a small stream a half mile northeast of the principal shaft, and considerable iron is said to have been made. It seems that the titaniferous ores could readily be smelted in the old Catalan forges and yielded a superior grade of iron. The Tuscarora mine consisted of several shafts extending about a mile along the ore belt. The principal shaft, the Sargeant, was situated a mile and a half north of Friendship. It reached a depth of 109 feet and a tunnel run in from this depth is said to have cut a bed 12 feet wide.

"Outcrops of granitic gneisses occur in the vicinity of the mine, but the immediate country rock is a gabbro. It is an olivine gabbro with diabasic texture, in which the feldspar laths reach a length of 2½ mm., and the pyroxene and olivine grains have a diameter of 1 to 1½ mm.

"No ore in place is now exposed, but judging from the fragments lying about on the surface it is a medium to coarse grained ore of good grade, in which the principal gangue consists of tufts and seams of chlorite and small quantities of material so decomposed as to make it undeterminable. Analyses 25 to 27 give the composition of the ore.

Metallographic Description of Ore

"Polished sections of this ore show very striking features. Gangue minerals constitute only a small part of the surface. Ilmenite grains make up one-fifth to two-fifths of the surface; and they range in size from 2 mm. to 0.2 mm., though very few fall below 0.5 mm. in diameter. The most striking feature of the ore is the ilmenite intergrowths in the magnetite, which attain a coarseness not approached in any of the other ores that have been studied. Indeed, so coarse are they as to be easily discernible with the naked eye. An etched specimen of the ore is shown in Fig. 1, in which the relations of the ilmenite and the magnetite grains and the heavy ilmenite laths in the magnetite are apparent. The individual ilmenite plates have an average length of 2 mm., but some attain a length of as much as 4 mm. The space between the parallel plates varies from 0.2 to 0.5 mm., and the plates themselves may be as thick as 0.1 mm. Another characteristic feature is protuberances or local thickenings of the plates. This most frequently takes place at one end, the other end thinning out, giving an elongated, wedge shaped appearance. These plates are plainly visible on cleavage faces of the magnetites on the unpolished surfaces of pieces that have been etched, and are frequently coarse enough to peel off with the edge of a knife blade.

Possibilities of Utilizing Ore

"The most satisfactory results of magnetic separation were obtained from this ore, as shown below:

Results of Magnetic Separation of Tuscarora Ore.

	Unscreened Ore, Per Cent	Ore Through 50-mesh, Over 100-mesh(*a*)		Ore Through Screen Finer Than 100-mesh(*b*)
		Magnetic, Per Cent	Nonmagnetic, Per Cent	Magnetic, Per Cent
Quanity		71.5	28.5	70.1
Fe	58.07	67.76	33.76	68.41
TiO_2	12.82	4.25	34.32	3.64

*a*44.6 per cent. *b*55.4 per cent.

"These results show that little is to be gained by grinding finer than 50-mesh; that is, notwithstanding the coarseness of the ilmenite intergrowths they are still too fine to be separated by grinding to 100-mesh. This, of course, is obvious from a comparison of the dimensions of the intergrowths given above and the size of the openings of the 100-mesh screen. If all the TiO_2 in the tailings is assigned to the ilmenite, they contain about 75 per cent ilmenite, with a residue of 6.38 per cent Fe. Some of this iron occurs in the gangue minerals present, so that very little magnetite is lost by adhering to the ilmenite or gangue. Although the titanium content of the concentrate is still higher than is acceptable in present blast-furnace practice, the concentrate is so high grade that it would make an acceptable ore to mix with titanium-free ore.

"Kerr [1] gives the results of a magnetic-separation test made with a common magnet on ore obtained from this same belt several miles northeast of the Tuscarora mine. They are even more favorable than those presented above.

Results of Magnetic Separation Test of Tuscarora Ore.

Constituent	Natural Ore, Per Cent	Magnetic, Per Cent	Nonmagnetic, Per Cent
Fe	41.95	67.60	21.63
TiO_2	15.35	1.27	16.20
SiO_2	12.75	1.30	26.80

[1]Report of the Geological Survey of North Carolina, vol. 1, 1875, p. 245.

Trueblood Plantation Ore

"About 2 miles northeast of the Tuscarora mine, on the south side of Brushy Creek, a little work has been done. The ore here also occurs in association with a gabbro. The gabbro is strongly uralitized and the feldspar sufficiently altered to make the twinning obscure in places. Diabasic texture is far less prominent than in the rock of the Tuscarora mine, and often lacking entirely. The average size of the grains is about 2 mm.

"The ore is not quite as coarse as the Tuscarora mine ore, and etched sections do not show the intergrowths as abundantly. Otherwise the ore at the two localities is very similar in appearance.

Apple Plantation Ore

"Some pits were put down on the Apple plantation just over the line in Rockingham County, southeast of the Haw River, but they are all filled now. Fragments of ore found on the surface are similar to the ore found on the Trueblood plantation. Of special interest to this locality are fragments of pink and gray emery. The occurrence of emery in this belt is first mentioned in Kerr's report,[1] in which he gives two analyses made by Genth. One analysis is of a reddish granular ore (analysis 52), which he describes as follows: "It has much the appearance of a granular reddish-brown garnet, for which it has been mistaken, until the analysis proved it to be not a silicate mixed with granular magnetite, but corundum." The other is of a granular grayish ore (analysis 53) described as follows: 'This is of a similar quality and is found at the same locality; the minute grains of corundum have a yellowish or brownish-white color, and show in many places cleavage fractures, which give it the appearance of a feldspathic mineral.' No mention is made of the locality where these specimens were found. Pratt and Lewis [2] state that the exact location is not now known, and give the McCarviston or McCuiston place, 7 miles northeast of Friendship, in Guilford County, as the probable location. The specimens found on the old Apple plantation fit the description given by Kerr exactly, and as no such material was found anywhere else in the belt, it seems probable that this is the locality from which Kerr's specimens were obtained. The rock was not found in place and no conclusions could be drawn as to the occurrence and size of the deposit.

[1] Report of the Geological Survey of North Carolina, vol. 1, 1875, p. 246.
[2] Pratt, J. H., and Lewis, J. V., Corundum and the peridotites of western North Carolina: North Carolina Geol. Survey, vol. 1, 1905, pp. 263-264.

Dannemora Mine

"Some work was done on the Shaw belt, 3 miles west of Summerfield, but the only extensive workings were those on the north side of the Haw River, close to the line between Guilford and Rockingham counties. Ore was worked from pits in Revolutionary times, and hauled to Troublesome Forge, 5 miles to the north. Subsequently a Philadelphia mining company worked the Dannemora mine on this property. The following description of the mine, given by Bailey Willis in the Tenth Census report,[3] is quoted because it gives the size of one of the ore lenses:

'The first work was done in incline No. 1. According to the statement of the superintendent, the ore gave out 10 feet from the surface but was found again 20 feet farther down; it widened to 12 feet, which is the thickness 90 feet from the surface in the incline, 70 feet vertically. At this depth a drift has been driven along the vein and stoping has been begun. A small winze has been sunk 20 feet farther on the incline, and the ore is said to narrow to 1 foot in thickness. Before the horizontal drift reached the second incline the ore was pinched out by the granite walls.

'As the ore body thus opened gives out just beyond incline No. 1, its dimensions are pretty well ascertained. It is approximately 125 feet long, 80 feet in incline width, and 12 feet thick. The drift has been extended to another lens of the same thickness, northeast of it, and the surface outcrops and trenches indicate the existence of others to the southwest. The ore is accompanied by chlorite and mica, which are sufficiently decomposed, even at the depth of the tunnel, to be readily dug with a pick. The ore is separated on the surface, by screening, into lump and fine ore, the former being shipped for fettling, the latter for blast-furnace use.'

"The ore lying about the old workings is somewhat leaner than the Tuscarora mine ore. It consists of a similar granular aggregate of ilmenite and magnetite with the gangue minerals, but the individual grains seldom exceed 1 mm. in diameter, and most of them are about 0.5 mm. Intergrowths of ilmenite in the magnetite grains are almost lacking.

Summary

"The titanium content of these ores is about the normal one for titaniferous magnetites. Of the large number of available analyses the average TiO_2 content is about 13 per cent. The ilmenite and the magnetite occur as granular aggregates in the ores in such a manner that most of the titanium can be eliminated with little loss of magnetite. The resulting concentrate runs high in iron and is low enough in titanium to make possible the utilization of these ores in normal blast furnace practice by mixing them with titanium free ores. On the other hand, little is

[3]Tenth Census, vol. 15. 1886, p. 308.

known in regard to their geologic occurrence and size on account of lack of exposures. Such conclusions as can be drawn from old data and the nature of the deposits are not very favorable to them. The ore bodies seem to be rather small and irregular in distribution, so that mining operations would be attended by considerable uncertainty. On the whole, therefore, the belt is not very promising as a source of iron ore.

Lincoln County

"See Catawba County.

Macon County

"There are a number of occurrences of titaniferous magnetite in Macon County east and south of Franklin, but none has been explored more than superficially.

"Five miles east of Franklin and one-eighth of a mile north of Cullasagee Creek there is a heavy surface float of massive lustrous magnetite high in titanium (analysis 40). The gangue is quartz and chlorite; the ore is traceable for several hundred yards along the summit of a hill in a northeasterly direction parallel to the strike of the decomposed mica schists near the foot of the hill.

"An analysis has also been made of the ore on land 4 miles southwest of Franklin and 2 miles above the mouth of Cartoogajay Creek (analysis 41). The ore is very fine grained, in a chloritic gangue, and in places slightly garnetiferous. The extent of the ore body is not apparent.

Madison County

"No important bodies of titaniferous ore are known in Madison County, though there are several occurrences of the ore.

"In the eastern part of the county, a half mile above the mouth of Paint Fork, small pieces of float ore high in titanium are found (analysis 43). The occurrence of a highly titaniferous ore is also noted near the road midway between Asheville and Burnsville (analysis 42).

"An occurrence showing only a moderate amount of titanium is that a half mile east of the Haywood County line near the headwaters of Spring Creek (analysis 44). It has a thickness of 5 to 6 feet near the surface and appears to widen in depth.

Mitchell County

"Titaniferous ores occur in Mitchell County in the Roan Mountain belt, the Pumpkin Patch Mountain belt, and on Iron Mountain.

"Titaniferous ores occur on one of the spurs of Iron Mountain 2½ miles above the mouth of Greasy Creek, near the Jenkins ore bank

(analysis 49). The ore body consists of a compact lustrous ore free from gangue, and attains a width of 5½ feet. The wall rock is hornblende gneiss and pegmatite.

"The Roan Mountain titaniferous belt lies several miles south of the Cranberry belt, to which it is parallel. Its eastern extremity is near the mouth of Roaring Creek on one of the southern spurs of Big Yellow Mountain. It crosses the State line on the summit of Grassy Bald Ridge, then, after traversing the eastern edge of Tennessee for about 4 miles, bends around to the southwest and reenters North Carolina near the headwaters of Big Rock Creek; thence it continues to the mouth of Big Rock Creek to the Yancey County line at Toe River. No ore bodies of any size have been found along this belt. At the eastern end some prospecting has been done, including the drilling of three diamond-drill holes. The results were discouraging, as the ores occur in lenses of 2 inches to 2 feet in width. The titanium content is only moderate in amount (analyses 45 and 46). The ore is compact, lustrous, and free from gangue, and occurs in a country rock of very coarse grained pegmatite, hornblende schist, epidote, and garnet rock.

"At the southwest end of the belt on the north side of Little Rock Creek a small pit exposes a bed 3 feet wide, which at a depth of 4 feet is cut out by a diabase dike (analysis 48).

"The Pumpkin Patch Mountain titaniferous magnetite belt lies to the northwest of Bakersville and has an extent of 5 to 6 miles. Some pits have been put down on the Parker place near the head of Wadkins Branch, 5 miles northwest of Bakersville, and loose blocks of ore encountered (analysis 47); the pits did not go deep enough to get the ore in place.

"All of these Mitchell County ores show approximately the same titanium content.

Rockingham County

"See Guilford County.

Yancey County

"The occurrences of iron ore in Yancey County are isolated and sporadic, and no notable occurrences of titaniferous ore have been disclosed.

"In the extreme western part of the county near the head of Possum Trot Creek, 9 miles west of Burnsville, is found float ore that shows a small amount of titanium (analysis 57). It is possible that this occurence belongs to the Roan Mountain titaniferous belt of Mitchell County.

"Another deposit occurs 6 miles north of Burnsville, on the south side of Mine Fork, a half mile above its mouth (see analysis 56). Two small openings were made 75 feet apart on the strike of the ore (N. 25°

E.) and show a vertical bed of ore 6 to 10 feet across. The ore is in a gangue of chlorite, small particles of quartz and feldspar, and a peculiar brown mineral of high luster which may be rutile or brookite. A quarter mile southwest of these openings is much surface float of this heavy brown mineral nearly free from magnetite. If this mineral is really rutile or brookite, considerable titanium could easily be eliminated by magnetic concentration."

Production

There is given in the table below the production and value of iron ores for North Carolina from 1900 to 1917, inclusive:

PRODUCTION OF IRON ORES IN NORTH CAROLINA, 1900—1917, INCLUSIVE.

Year	Amount, Long Tons	Value
1900	21,000	$ 42,000
1901	2,578	4,997
1902	34,336	52,771
1903	82,851	78,540
1904	64,347	79,846
1905	56,282	70,352
1906	56,057	75,638
1907	75,638	113,488
1908	48,522	76,877
1909	61,150	107,013
1910	65,278	114,237
1911	84,782	148,369
1912	68,322	186,264
1913	69,235	211,791
1914	57,667	100,917
1915	66,453	116,472
1916	64,306	249,948
1917	90,957	445,898

Owners and Producers of Iron Ore in North Carolina During 1917

Cover and Porter, Andrews, Cherokee County, N. C.....Cover Mine
Ferebee & Young Co., Andrews, Cherokee County, N. C..Faco, Nos, 1, 2 and 3
Coe & Holland Co., Andrews, Cherokee County, N. C....Coe-Holland Mine
J. W. Porter, Andrews, Cherokee County, N. C.....Adams Mine
Latham & Swan, Andrews, Cherokee County, N. C.....Latham & Swan Mine
John J. George, Cherryville, Gaston County, N. C.....Ellison Ore Bank
Cranberry Furnace Co., Johnson City, Tenn.....Cranberry Mine, Avery County
J. W. Welch, Marble, Cherokee County, N. C.....Welch Mine
Marble Iron Mining Co., care Anson G. Betts & Co., Asheville, N. C.....Marble Mines Cherokee County

Shut-In Iron Mines, Inc., care Anson G. Betts & Co.,
Asheville, N. C.....Shut-In Mines,
Madison County
J. S. Stanbury, Marble, Cherokee County, N. C.
N. C. Bessemer Co., Thos. M. Gorman, Sec'y, Durham,
N. C.....Mines,
McDowell County
Charlton B. Rogers, 154 4th Ave., Nashville, Tenn.....Mines,
Cherokee County
J. T. Hayes, Tomotla, Cherokee County, N. C.
A. K. Knickerbocker, Hot Springs, Madison County, N. C.
W. R. Lunsford, Marble, Cherokee County, N. C.....Marble Mine
Rolin Dockery, Marble, Cherokee County, N. C.....No. 6 Mine
F. R. Seeley, Murphy, Cherokee County, N. C.

TIN

A report has recently been published by the United States Geological Survey on "The Tin Resources of the Kings Mountain District of North Carolina and South Carolina." Because of the value of this report to those interested in the North Carolina tin deposits, it is incorporated with this report.

Tin Resources of the Kings Mountain District, North Carolina and South Carolina*

BY ARTHUR KEITH AND DOUGLAS B. STERRETT

INTRODUCTION

The Kings Mountain district, in which the tin ores here described are found, is included in the Gaffney, Kings Mountain, Lincolnton, and Gastonia quadrangles mapped by the United States Geological Survey. The district is almost equally divided between North Carolina and South Carolina, the part in North Carolina being a little larger.

The examinations on which this report is based were made by the authors in preparing the Gaffney-Kings Mountain and Lincolnton-Gastonia folios of the Geologic Atlas of the United States. A previous and less detailed examination was made by L. C. Graton.[1] Mr. Sterrett carried on his work in 1908 and in subsequent years up to 1914. The district has also been examined in detail by Mr. Keith, in company with Mr. Sterrett, with special reference to the general geology and the formations and structures of the region.

*Bull. 660-D of the U. S. Geol. Survey.
[1]Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, 1906.

GEOGRAPHY

The Kings Mountain district is in the central part of the Piedmont Plateau, of which it may be considered a typical area. The country is one of broad, flat or gently rolling ridges that become more broken near the larger streams, where deep valleys have been cut. The sky line as viewed from the higher ridges is that of a nearly level plain, above which stand a few elongated hills and mountains, called monadnocks. Most of these hills are in a narrow, central, northeastward trending belt.

A few low ridges rise above the plateau surface in the southeastern part of the Lincolnton quadrangle, but these do not compare in height and roughness with the more prominent peaks in the Kings Mountain quadrangle, to the south. The smooth, broad ridges pass rather sharply into steeper slopes at the foot of the monadnocks and near stream valleys. Many of the valleys in these quadrangles are rather broad and have nearly flat bottoms, but some are V-shaped, with steep walls. The relief where the rivers and larger streams are cutting through hard rocks is considerable, and the hillsides are steep and rocky.

Characteristic developments of the rolling upland country may be seen between Kings Mountain and Cherryville and on to the northwest beyond Flay. The relief for considerable distances along the ridges in these areas is low, and the side valleys are shallow. The cultivated lands are smooth fields with deep residual soil and only scattered outcrops of rock.

The plateau ranges in elevation from 750 to 1,050 feet above sea level, but most of it is between 850 and 1,000 feet. The highest parts are in general on the northwest, and there is a decided general slope to the southeast. The stream valleys are cut 50 to 200 feet below the general plateau surface, and the residual hills, or monadnocks, stand from 100 to 700 feet above it. The highest points are Kings Mountain Pinnacle, 1,705 feet, and Crowders Mountain, 1,624 feet above the sea.

The town of Kings Mountain is situated at an elevation of 1,000 feet on the principal divide, which has a general northwest course between the drainage basins of Catawba and Broad rivers and separates the district into nearly equal parts. Broad River takes a southeasterly course through the Gaffney quadrangle and across a corner of the Kings Mountain quadrangle. Its principal tributaries are Kings, Bullocks, Buffalo, Cherokee, and Thicketty creeks and First Broad River. The chief tributaries of Catawba River are Indian, Crowders, Allisons, Clark, and Beaverdam creeks and the South Fork of Catawba River.

The Southern Railway runs from southwest to northeast through the middle of the district and connects most of the principal towns, including

Gaffney, Blacksburg, Kings Mountain, Bessemer City and Gastonia. The Kingville and Marion branch of the Southern Railway runs from southeast to northwest and crosses the main line at Blacksburg. A branch of the Seaboard Air Line Railway runs southwestward through Lincolnton and Cherryville. Between Bessemer City and Gaffney the Southern Railway passes within a mile or two of the tin belt, and no known deposit of tin ore in this belt is more than 3 miles from a railroad.

Descriptive Geology

Piedmont Plateau

The rocks of the Piedmont Plateau are of both igneous and sedimentary origin. Both kinds of rock have been metamorphosed in many places. In some localities the metamorphic igneous and sedimentary rocks are not sharply distinct, for the metamorphism has been so extreme that nearly all traces of original sedimentary or igneous nature have been obliterated. In many places also the metamorphic igneous rocks are not sharply separable from the ordinary igneous rocks, for a single intrusive mass may have become metamorphosed in some parts, especially near its borders, during processes of mountain building and may show little or no evidence of change in other parts, particularly in the interior.

The metamorphic rocks of sedimentary origin in the Piedmont Plateau consist of gneisses and schists, the principal varieties of which are those characterized by muscovite, or biotite, garnet, kyanite, staurolite, chlorite, sericite, ottrelite, and, in some rocks, quartz and calcite. All these varieties have resulted from the metamorphism of ancient sedimentary rocks such as conglomerates, sandstones, shales, limestones, and numerous intermediate kinds. By metamorphism sandstone became quartzite, impure or shaly sandstone became graywacke and gneiss, shale became schist, and limestone became marble. Variations in composition of the original sediments are represented by variations in the metamorphic rocks. Some of the sediments were in part of volcanic origin, such as volcanic ash or tuff laid down in water with varying amounts of detrital material derived from ordinary land waste. The metamorphism of these rocks has produced varieties of crystalline rocks transitional between those of purely sedimentary origin and those of purely igneous origin.

The metamorphism of some of these igneous rocks has been so extreme that they have become mica and garnet gneisses or schists that are indistinguishable from similar foliated rocks of sedimentary origin. Diorite

and many basic igneous rocks have become hornblende gneiss, hornblende schist, chlorite schist, serpentine, soapstone, etc.

The igneous rocks of the Piedmont Plateau include a wide range of such rocks as are generally classed as granite, diorite, gabbro, pyroxenite, peridotite, porphyries, and diabase, with many intermediate varieties. Some have been intruded as batholiths, laccoliths, sills, dikes, or stocks; and others have been poured out as surface flows. The eruptions occurred during several epochs. The older intrusives have been more or less metamorphosed and, as stated above, are not everywhere sharply distinct from the metamorphosed volcanic and sedimentary rocks.

The strike of the formations of the Piedmont Plateau is generally northeast, or approximately parallel with the trend of the plateau and the bordering Appalachian Mountains, but locally the strike may be nearly at right angles to the prevailing trend. The dip of the formations is generaly high but is variable, and as a rule it is southeast.

Kings Mountain District

The district here described contains both metamorphic and igneous rocks, and the metamorphic rocks include some of sedimentary and some of igneous origin. In age the rocks range from Archean to Triassic. The Archean rocks occupy most of the district, especially its northwestern and southern parts. Through the middle of the district from southwest to northeast extends a belt of probably Cambrian rocks, including schists, quartzites, conglomerates, and marble, and of probably Algonkian rocks, including schists and tuffs. The Archean rocks have been cut by masses of later igneous rocks—granites, diorites, etc.—some of which are of great size. The diorite and one body of granite are pre-Cambrian; two other granite masses are late Paleozoic, perhaps Carboniferous. The formations that are associated with the tin deposits are the Carolina gneiss and Roan gneiss, of Archean age; the Bessemer granite, of pre-Cambrian age; the Whiteside granite and, especially, tin-bearing pegmatites of late Paleozoic age. The other formations represented in the district are not associated with the tin ores and will not be considered here.

STRUCTURE

The rocks of the district have been extremely folded, to some extent faulted, and greatly metamorphosed. The structural features resulting from extreme compression run in general northeast, as is usual in the Appalachian Mountains and Piedmont Plateau. The Cambrian (?) and Algonkian (?) rocks lie in a corrugated synclinal trough between uplifted belts of Archean gneisses and later granites. This trough is

double, having two major downfolds, between which pre-Cambrian rocks reach the surface. In the Archean rocks along the northwest side of this general trough, at distances of 2 miles or less from their border lies the tin belt. In the area between Kings Mountain and Gaffney this boundary between the Cambrian (?) and Archean rocks coincides with a fault that dips about 45° NW. The folds of the rocks in the tin-bearing belt range in trend between N. 60° E. and N. 20° E. and are comparatively regular and straight, as are also the folds of the Cambrian (?) and Algonkian (?) formations. On both sides of this middle belt there are many and great local departures from this regular structure. In the tin belt the rocks dip northwest at various angles, usually high. Most of the minor folds are closed and overturned and are very difficult to detect. The faults, doubtless numerous, are likewise obscure, and comparatively few have been traced. The only one known to have affected the tin belt is the boundary fault mentioned above.

Carolina Gneiss

Distribution.—The Carolina gneiss, so named because of its extensive development in the Carolinas, is the most widespread formation in the district, as well as the oldest rock in the region. It is most prominently developed in the northwestern part of the district, and no large body of it is known southeast of the middle syncline of Cambrian (?) rocks. It has been cut into elongated and irregular shaped bodies by masses of intrusive igneous rocks.

Character.—The Carolina gneiss consists of an immense series of interbedded gneisses and schists, prominent among which are mica gneiss and schist, garnet gneiss and schist, and kyanite gneiss and schist, with intermediate varieties and granitoid layers. Less abundant are gneisses and schists characterized by graphite or staurolite. Practically all the gneiss and schist contains quartz and mica, either muscovite or biotite, but rock that contains other minerals, such as garnet or kyanite, receives its name from these. Thus garnet gneiss or schist may contain either muscovite or biotite or both, quartz, feldspar, and numerous accessory minerals.

The mica gneisses and schists are so diverse in texture and composition that it is difficult to give a general description of them. The schists range in texture from coarsely crystalline to fine grained and in many places exhibit variations both in grain and in mineral composition within a thickness of a few inches. Most of them are composed of quartz and biotite or muscovite, with or without feldspar, magnetite, and various other minerals. In some the mica scales are fine to medium in size; in others they are as much as a quarter of an inch in diameter. The

coarsely crystallized kinds are commonly associated with granite or pegmatite. The quartz and other minerals of the schists occur in aggregates showing about the same range in grain as the mica scales.

The schists are strongly foliated in consequence of the grouping of their mineral grains with their longer dimensions roughly parallel. The cleavage of the mica is parallel with the schistosity of the rock, and the scales wrap or fold around the ends of the other minerals or inclose lenticular masses of them. The quartz of the schists occurs in flattened or lenticular aggregates of small grains. These lentils may be separated or connected by small seams of quartz.

The structure of the schists renders them fissile, cleavage readily taking place both between the different mineral grains and through the more cleavable minerals, such as mica. In some schists cleavage in more than one direction has been developed by compression of the rocks in more than one period and in different directions. In some rocks the later cleavage, or "slip cleavage," is due to a parting or slipping developed along a series of small, close folds. In places mica scales have been formed along such slips, so that the structure closely resembles the original schistosity. Another variation in the mica schists is due to the development of scattered coarse mica crystals with the cleavage turned about at right angles to the schistosity. Such crystals have been developed by metamorphism later than that by which the schistosity was produced.

The mica gneiss of the Carolinas is varied in texture and composition. In one sense it may be considered as composed chiefly of a large variety of interlayered schists, the gneissic structure being due to the association of numerous unlike layers. A portion of the Carolina gneiss, however, is composed of granitoid layers that consist of feldspar, quartz, and either or both muscovite or biotite with numerous accessory minerals. The texture of this variety is commonly much coarser and the foliation less pronounced than in the mica schists. Some of this gneiss has developed from homogeneous rocks and consequently has a rather uniform texture and banding. Other masses have been derived from rocks of diverse composition and consequently show strong banding with contrasts in texture.

The ordinary gneisses and schists grade into other kinds by the addition of such minerals as garnet, kyanite, and graphite. Where garnet and kyanite are abundant and occur in large crystals the texture of the schists differs substantially from that of ordinary mica schist. Garnet and kyanite tend to crystallize with but little adaptation to the parallel arrangement of the other minerals of the schists and accordingly pro-

duce a porphyritic texture. Graphite, however, occurs in plates or scales parallel with the mica, and its presence does not change the general texture of the schists.

The interlayering of and gradations between mica schists and gneisses and those containing garnet and kyanite are so prevalent and intimate that it is practically impossible to show all varieties separately on a map.

Roan Gneiss

Distribution and name.—The Roan gneiss, named from Roan Mountain, on the North Carolina-Tennessee border, where the formation is extensively developed, occurs in large masses and in belts or dikelike bodies cutting the Carolina gneiss in practically the whole of the district. It forms most of the surface at the south border of the district, and in the north-central part it occurs in areas 2 to 5 miles wide, most of which have very irregular outlines, especially near the intrusive bodies of Whiteside granite.

Character.—The Roan gneiss consists chiefly of hornblende schist, hornblende gneiss, schistose diorite, and diorite. In places there are intercalated layers of mica schist and gneiss and garnet schist and gneiss not essentially different from similar rocks of the Carolina gneiss. The hornblende beds are black or dark greenish black in color, and the other schists are light to dark gray. The hornblende rocks are of uniform composition, even in rather large bodies. Massive diorite occurs in some of the larger masses of Roan gneiss, but most of the rock is somewhat schistose. Very schistose varieties that are apparently composed almost wholly of hornblende are called hornblende schist but are as a rule merely modifications of the diorite. In places hornblendic layers are separated by layers of quartz or feldspar, and the rock is designated hornblende gneiss. The hornblendic rocks range from those of fine texture to those in which some of the crystal grains measure half an inch across. The mica and garnet gneisses and schists within the Roan gneiss are probably masses of the Carolina gneiss included in the original diorite at the time of intrusion or subsequently interfolded with the Roan gneiss. Pegmatite occurs through much of the Roan gneiss, as in the Carolina gneiss.

Bessemer Granite

Distribution and name.—The Bessemer granite crops out in several broad bands in the central part of the district. The main band lies southeast of the general central trough of Cambrian (?) sedimentary rocks, and smaller bodies of the granite appear between its two main

parts. One of these minor bodies expands to the north and in the Lincolnton quadrangle underlies Bessemer City, for which it is named.

Character.—The Bessemer granite is a medium to fine grained muscovite biotite granite near quartz monzonite in composition. It is locally porphyritic. In all outcrops it has a strong schistose structure, and in many places it has been metamorphosed into white and gray quartz sericite schists that bear no resemblance to the original granite. Only in certain favorable outcrops can the gradation from the schistose granite to sericite schist be seen. The porphyritic varieties of the granite have in some places been metamorphosed into quartz-augen sericite schists or "bird's-eye" schists.

In the less altered parts of the granite the constituent minerals are quartz, orthoclase, oligoclase, muscovite, biotite, and a little magnetite and zircon, with secondary clinozoisite and chlorite. In the metamorphism of the Bessemer granite to quartz sericite schists the muscovite has been largely recrystallized into finer scales and the potash feldspar has passed into fine scaly sericite. The quartz has in part recrystallized, but the larger grains or phenocrysts retain more nearly their original size and position. Much silica has been set free in alteration during metamorphism and deposited in the form of quartz veins cutting the sericite schists. The Bessemer granite yielded more easily to processes of metamorphism than the granitic rocks of the Carolina gneiss.

Pegmatite

Pegmatite is abundant in the area of Archean rocks, and a few small deposits have been observed in other formations. The rock is variant in composition but normally is composed chiefly of feldspar and quartz, with or without mica and other minerals. In some varieties feldspar is practically absent, and the pegmatite is composed chiefly of quartz and mica. Pegmatite is allied to granite in composition but is of more varied and much coarser texture. In some of it individual minerals may measure more than a foot across.

The pegmatite occurs in sheets, lenses, and irregular masses ranging in thickness from a few inches to many yards and attaining half a mile in length. These masses may follow the bedding or the schistosity of the country rock or may cut across them at various angles. Most of the deposits are too small to be shown on any ordinary geologic map, but some of the larger ones and those of special interest because of their mineral associations have been mapped and will be shown in the folios describing this district, which are now in preparation. A few of the pegmatites have a pronounced schistose structure, but most of them are

massive. Some of the pegmatites are probably of Archean age, but the majority are probably younger and are genetically connected with post-Cambrian granite intrusions, especially with the Whiteside granite. The mineral composition and variations of the pegmatites are given in considerable detail in the descriptions of the mines and prospects (pp. 135-146).

Whiteside Granite

Distribution.—The granite of this region that has been correlated with the Whiteside granite of the Pisgah and other quadrangles to the west covers large areas of the Kings Mountain district. It has been observed at many places in the region between this district and the Pisgah quadrangle, and it has been mapped in the Morganton, Mount Mitchell, and Saluda quadrangles of North Carolina. The name is taken from Whiteside Mountain, in the Cowee quadrangle, west of the Pisgah quadrangle, where the granite crops out in tremendous cliffs. Because of its relations to the associated rocks, the Whiteside granite is considered to be of later age than Cambrian, and possibly it was intruded during the mountain building period at the end of the Carboniferous.

Character.—The granite is composed chiefly of orthoclase, microline, and oligoclase feldspar, quartz, muscovite and biotite mica, and such accessory minerals as magnetite, apatite, and zircon. Minerals of secondary development are garnet, epidote or zoisite, chlorite, and kaolinite. The feldspars are the predominant minerals and the micas the most variable in abundance. Muscovite is more plentiful than biotite. Garnet is plentiful in some parts of the granite, especially those which have received a schistose structure through metamorphic processes; in some of these the garnets measure a tenth of an inch in diameter.

The granite is generally of light gray color, and those varieties in which biotite is scarce are nearly white. Most of it has a medium to fine grain, especially in the smaller masses. In some places it shows a porphyritic texture, as in parts of the mass in the northeast corner of the Lincolnton quadrangle. The porphyritic forms appear much coarser grained because of the considerable size of the feldspar phenocrysts. Variations occur in different parts of the same bodies of the granite, some showing porphyritic phases and others the more even grain characteristic of the greater part of the Whiteside granite.

The Whiteside granite has yielded to metamorphism to varying degrees. In many places there is a gradation from typical granite in the interior of a mass to strongly schistose or gneissic granite at the border. The bulk of the granite shows only moderate metamorphism.

In places the Whiteside granite exhibits flow banding marked by an arrangement of minerals in roughly parallel layers. This structure may have developed in two ways, either during the intrusion of the granite magma in which a partial segregation of the minerals had already taken place or by the mashing and flowing under pressure of granite which contained partly absorbed masses of other rocks. These processes have yielded rocks characterized by discontinuous irregular wavy bands of different minerals. The flow structure may be present in one part of a granite mass and absent in another a few feet distant.

Relations.—The Whiteside granite is intrusive into all the rocks with which it is in contact in these quadrangles except the Triassic diabase dikes. Intrusive relations are shown by the doming action of batholiths, from the borders of which the layers of gneiss dip away at various angles, by the inclusion of masses of the gneisses with which it is in contact, by the occurrence of dikes both conformable with and cutting across the layers of the inclosing gneisses, and by the relations of the granite to pegmatite that cuts other rocks.

The best illustration of batholithic intrusion is around Cherryville, where the Whiteside granite has invaded the gneiss as a great batholith and also as sills, especially to the southwest of the main mass. The interlayered masses of gneiss and granite dip away from the main mass of granite to the south and southwest.

Sill-like dikes of the granite are abundant in the gneisses, especially near the batholiths, and in some places these dikes branch out or turn across the schistosity, cutting from one layer to another.

Irregular bodies of pegmatites occur in the granite and extend from it out into the surrounding rocks. The texture of these pegmatites varies from extremely coarse to that of a coarse granite. In places pegmatite appears to grade into the granite. The invariable association of the pegmatite with the granite and the gradation of the one into the other show that they are related in origin. In places the gneisses and schists have been intruded by dike after dike of granite and injected by so much pegmatite that, with the unsatisfactory outcrops in this region, it is impossible to determine which rock is the more abundant, the original gneiss or the granite and allied pegmatite.

Inclusions.—Within the Whiteside granite are included numerous masses of the rock intruded by it, but this relation is best exhibited where the hornblendic rocks of the Roan gneiss are intruded by the granite, especially in a large area 3 to 5 miles south of Cherryville, in the Lincolnton quadrangle. Many of the inclusions have been more or less absorbed by the granite magma, which they have changed in composition. The absorption of the schists of the Carolina gneiss has yielded

streaks of highly micaceous granite grading into highly micaceous schist. When they were intruded the hornblendic formations were broken up into more blocklike bodies, which floated out into the granite magma. Such inclusions were more or less dissolved by the inclosing magma, so that the magma became more basic near them. Thus the composition of the granite may be changed over considerable areas, and gradations occur from diorite inclusions seemingly to quartz diorite, to hornblende-biotite granite, to granite rich in biotite, and to the normal Whiteside granite.

The Tin Deposits

General Features

Distribution.—The presence of cassiterite, oxide of tin, at many places in the Kings Mountain and Lincolnton quadrangles, at one place near Gaffney, in the Gaffney quadrangle, and at one locality in the Gastonia quadrangle has led to much prospecting and to attempts at mining. In at least one place—the Ross mine, near Gaffney—placer mining was temporarily done at considerable profit. Several prospects have also been opened in the Lincolnton and Gastonia quadrangles north and northeast of the Kings Mountain quadrangle. Practically all the work on cassiterite-bearing veins has been done at a loss, but this work has not been sufficiently conclusive to prove or disprove the value of some of the deposits.

The cassiterite deposits have been found in a belt extending from a point 2 miles northeast of Grover, about parallel with the general trend of the rock formations, through the town of Kings Mountain and northeastward to Beaverdam Creek, 6 miles from Lincolnton. So far as known the Ross tin mine, near Gaffney, is on an isolated deposit, but this lies in about the same belt of rock formations as those between Grover and Kings Mountain.

Inclosing rocks.—The tin deposits occur in pegmatite masses within Archean rocks, either the Roan gneiss or the Carolina gneiss along or near its contact with the Roan gneiss. The belt of deposits lies within a mile northwest of the belt of Cambrian(?) rocks in the Gaffney and Kings Mountain quadrangles. To the north, in the Lincolnton quadrangle, the tin deposits diverge more widely from the Cambrian (?) rocks, but in the Gastonia quadrangle, east of the Lincolnton, they approach those rocks again.

The rocks inclosing the pegmatite are hornblende schist, hornblende gneiss, diorite, mica schist, and mica gneiss, with or without accessory garnet and kyanite. These formations have steep dips along the tin belt.

Occurrence of pegmatite.—The pegmatite occurs in sheets and lens shaped bodies cutting the gneisses and schists. Some of the pegmatite masses are conformable with the structure of the inclosing schists, but others cut across the schist layers with various dips and strikes. Inclosed in the same formations are many other pegmatite bodies which are more or less similar to those bearing cassiterite but in which this mineral has not yet been found.

There are great variations in mode of occurrence and character of the pegmatite of the tin belt, including those which contain cassiterite. The masses range from less than an inch to 100 feet in width and from a few inches to probably more than half a mile in length. Some are only little longer than they are wide; others occur as large thin sheets. Some of the pegmatites occur in more or less parallel position, others in a belt with overlapping ends or in line with one another, and others lying at various angles with one another. The occurrence, where exposures are poor, of several bodies of pegmatite lying parallel and a few feet apart has misled some observers in estimating the width of some of the deposits. The pegmatite masses may fork or have connecting branches. They may turn, swell, pinch out abruptly or taper down at the ends. These variations may occur in different planes. Some of the pegmatites are more regular than others and hold one direction of strike or dip for considerable distances. The greatest irregularities occur in those bodies which cut across the schists or gneisses, or in those which branch from deposits otherwise conformable with the schistosity of the inclosing rock.

Origin of pegmatite.—The relations of the pegmatites to the inclosing rocks are chiefly those of intrusives, modified in some places by the action of solutions or gases. It is possible that some of the pegmatites have been deposited from aqueo-igneous solutions, but probably the majority, especially of the larger massive deposits, were mass intrusions. To which class many of the different pegmatites belong is a matter of uncertainty. Both types are supposed to be the products of granitic magmas that contained an excess of water and possibly gases and other mineralizing agents under conditions of heat and pressure. In the crystallization of a granite magma water is expelled and in part accumulates in the portion of the magma that remains unsolidified. This remaining magma accordingly becomes more fluid and may be regarded as an extremely hot concentrated aqueous solution. The expulsion of this liquid magma or solution into surrounding rocks gives rise to masses of pegmatite, which grade between typical dikes and typical veins.

Composition of pegmatite.—The pegmatites of the tin belt, including those that carry cassiterite, are somewhat diverse in composition. Some

are composed of the usual minerals, feldspar, quartz, and mica, without appreciable quantities of other constituents. Others carry spodumene and cassiterite. Cassiterite occurs both in pegmatites which contain spodumene and in those which do not. The other minerals observed in the cassiterite-bearing pegmatites are few and not important. Such minerals as wolframite and arsenopyrite, which are associated with tin ore in other regions, appear to be absent here. The variations in composition consist chiefly in variations in the proportion of the different minerals present. In some deposits feldspar predominates; in others quartz; in some mica is absent and in others abundant.

Great irregularities occur in the distribution of the minerals. Quartz is segregated into large separate masses in some deposits and mixed through the rock in coarse grains in others. Cassiterite in small deposits occurs in scattered grains through one part of the pegmatite body and is absent a number of feet distant in another part. In some of the large pegmatite bodies the cassiterite is irregularly scattered through large masses of the rock, and in others it occurs more or less irregularly concentrated along one wall of the pegmatite as a smaller vein but connected with the main mass. In some of the pegmatites rich in cassiterite, feldspar is only sparingly present if at all. This kind of deposit, then, has the nature of greisen and has been observed as lenses or streaks in larger bodies of pegmatite and along the contacts of such bodies with the inclosing rocks.

The cassiterite appears to have been one of the first minerals in the pegmatite to crystallize. Its boundaries are sharp, although crystal outlines are rather rare. Nowhere has a gradation between cassiterite and quartz or feldspar been observed, as there would be if the cassiterite had been introduced by metamorphism after the pegmatite was formed; nor are there inclusions of other minerals in the cassiterite. Accordingly it seems clear that the cassiterite was an original constituent of the pegmatite—a view which has already been stated by Graton. In some places the concentration of the cassiterite in greisen along the pegmatite border indicates metamorphic action, during which there were mutual reactions between the dike and the wall rock. The cassiterite, the earliest mineral to crystallize, formed first near the wall. The reaction of wall rock and dike is also evident by the unusual coarseness of the mica schist of the wall in many places.

Age of tin deposits.—The rocks in the tin belt are of two classes—(1) the gneisses, etc., of Archean age, and (2) the granites, pegmatites, and quartz veins, which cut the Archean rocks. The Archean rocks are greatly altered by deformation, but the younger rocks show little or no alteration. The Whiteside granite was locally rendered schistose but for

large areas is massive and unaltered. It is therefore concluded that most of that granite is younger than the mountain-building movements which deformed and altered this entire region. This conclusion assigns to the Whiteside granite a late Carboniferous age. Similar reasoning assigns a late Carboniferous or post-Carboniferous age to the pegmatites and quartz veins.

It seems probable that granite, pegmatites, and quartz veins form a cycle, the granite having invaded the Archean rocks nearly at the end of the Carboniferous period, the pegmatites representing a later stage of intrusion, partly in mass and partly by permeating solutions, and the veins being the final products of the cooling magma. The general distribution of the rocks favors this view, for the tin-bearing pegmatites are not in the granite but are near its general southeast margin, while the quartz veins, more or less mineralized, occupy a general belt southeast of and farther away from the granite.

Mines and Prospects

Gaffney Quadrangle

Ross Mine

The Ross tin mine is about 1½ miles northeast of Gaffney, on the northwest side of a small hollow that drains northeastward into a tributary of Providence Branch. The work consists of many open cuts and placer washings, pits, and trenches, and a shaft more than 130 feet deep, with levels, all within a space about 600 feet long from northeast to southwest and 100 feet wide. Placer mining has been done on the lower part of the slope, where water was available, and material obtained above this place has been carted down to the sluice boxes. In this way the greater part of the hill slope from a point near the shaft northeastward to the branch, a distance of about 400 feet, has been worked over.

The shaft and underground workings were not accessible at the time of visit, but portions of the vein were exposed in shallow workings, and these, with descriptions by Sloan and Graton, furnish material for the notes here given. A crosscut was driven from the shaft northwest to the vein on the 63-foot level, and winzes were sunk on the vein from this level to the 90-foot level and there connected by a drift. The shaft cuts the vein at a depth of nearly 100 feet.

The placer material consisted both of weathered vein material approximately in place and of hillside débris derived from the vein. Where the loose material only was washed, the work was carried only a foot or two deep, but where the weathered outcrop of the vein constituted the placer material, excavation was carried to depths of more than 10 feet.

The country rock consists of interlayered hornblende schist and fine biotite gneiss, probably belonging to the Roan gneiss. These rocks strike about northeast, and dips were measured ranging from 25° SE. in the branch to 60° SE. in the mine workings. Along the stream the rocks are only slightly altered, but in the underground workings the saprolite was found to extend to depths greater than 60 feet, passing gradually into less altered rock. From the lower workings hard, fresh wall rock was brought up but the vein material is partly altered to the bottom of the mine. The wall rock on the dump consists of rather coarse hornblende schist and garnetiferous biotite gneiss. The pegmatite in the upper workings is decomposed by Kaolinization of the feldspars. Specimens examined from the lower workings are hard, compact, and schistose and contain an abundance of compact fine sericite or pinite and a fibrous mineral like sillimanite. Under the microscope were observed partly sericitized orthoclase, oligoclase, muscovite and sericite, sillimanite, cassiterite, a prismatic mineral that is probably staurolite, and iron ore.

In the upper workings the streaks of hornblende schist have weathered to dark yellowish-brown saprolite and the mica and garnet gneiss to dark-grayish saprolite. The pegmatite is represented by masses of white kaolin and a little intermixed quartz with some mica.

The cassiterite-bearing pegmatite occurs as a series of irregular sheets and lenses approximately conformable with the inclosing gneiss and schists—that is, it has a northeast strike and a dip of 50°-60° SE. The train of pegmatite bodies, or "vein," is from 1 to nearly 10 feet wide, and the individual masses measure from less than an inch to 4 feet in width. The tin content varies widely. Graton mentions a 100-pound sample taken across a pegmatite body on the 75-foot level which contained 9 pounds of cassiterite, or about 6.5 per cent of metallic tin.

Most of the ore taken from the Ross mine was decomposed and soft and could be readily concentrated in sluice boxes. The ore taken from the lowest workings, however, was hard and would require crushing before concentration. The concentrates obtained have generally averaged over 65 per cent metallic tin. Sloan states that the total shipments of cassiterite concentrates from the Ross mine to 1906 amounted to about 130 tons. The shaft was sunk to its present depth in 1907. Since that time only a little surface testing with some sluicing has been done, resulting in a production of a few thousand pounds of concentrates.

Kings Mountain Quadrangle

Localities

Twenty or more places in the Kings Mountain quadrangle have been prospected for cassiterite. During 1907 the Blue Ridge Tin Corpora-

tion worked in the town of Kings Mountain and at several places southwest of the town along a line of prospects opened by Ledoux & Co. in 1888 and 1889. A promising prospect on the Faires place was tested by Capt. S. S. Ross and others, of Gaffney. Named in order from the North border of the Kings Mountain quadrangle to the south and southwest some of the mines and prospects are: The old Blue Ridge Tin Corporation mine, on the west side of the railroad tracks in the town of Kings Mountain; Mrs. Elizabeth Falls's prospect, two-thirds of a mile south of the town; the Faires prospect, eight-tenths of a mile west of south of the town; prospects tested by the American Tin Plate Co., adjoining the Faires prospect on the southwest; the Mike Plonk prospect, 1¼ miles southwest of the town; a series of openings made by Ledoux and Co., beginning 1½ miles southwest of the town and extending one-third of a mile southwest along a ridge; an old prospect opened by Ledoux & Co., 1¾ miles southwest of the town; the principal workings of the Blue Ridge Tin Corporation, 2 to 2⅓ miles southwest of the town, consisting of two shafts, drifts, and some placer work; three prospects of the Blue Ridge Tin Corporation, beginning west of the placer ground and within half a mile to the southwest; other prospects to the southwest and one two-thirds of a mile southeast of Crocker opened by Capt. Ross in 1903. Still other prospects farther southwest are reported but were not examined. Float tin has been found at other places in the town of Kings Mountain and along the belt southwest of the town.

Kings Mountain Mine

At the Kings Mountain mine of the Blue Ridge Tin Corporation three shafts were sunk from 50 to 75 feet deep and some drifts run from them. Two of the shafts were about 50 feet apart and near the railroad tracks. A mill for treating the ore was erected close by. The third shaft is about 150 feet west of the mill and on a different "vein." The workings were not available for examination at the time of visit and little could be learned of the result of the operations. Rich ore was found in pegmatite débris on the surface and similar rich ore was reported from parts of the underground workings.

The country rock is strongly folded coarse mica schist with a body of similarly folded hornblende schist less than 100 feet to the south. The strike of the schistosity of these rocks is north to west of north and the dip about vertical, but the contact of the two formations runs as a whole nearly east, although jagged in detail. This is due to rather close folding with a strong northward pitch in the folds. The cassiterite-bearing pegmatites are nearly conformable with the schistosity of the inclosing rocks, and the ore shoots would probably be found to pitch northward in

conformity with these folds. The pegmatites are variable in width, ranging from less than a foot to several feet as exposed near the collar of the western shaft. Most of the pegmatite, especially that rich in feldspar, is weathered and soft in the upper part of the workings, but some of the greisenlike ore rich in cassiterite is but little altered, even at the surface.

Cassiterite-bearing pegmatite crops out about 150 yards southeast of this mine in the gutter of one of the side streets of Kings Mountain and is reported to have been found in a well about 300 yards farther south. A number of loose cassiterite crystals were found one-third of a mile west of the railroad on both sides of the street leading toward Shelby.

Falls Prospect

The Falls prospect is on the east side of a small hollow in the south part of the town of Kings Mountain. It was tested a number of years ago by trenching along the hillside and sinking some shafts. Large pegmatite bodies were exposed in the hillside workings, but little cassiterite was found in them. A shoot of rich greisen was found in a shaft on top of the hill east of the trenches. Here the cassiterite-bearing greisen formed a pocket or shoot about 2 feet wide in a body of pegmatite about 8 feet wide. The pegmatite is inclosed between chlorite schist on the northwest and mica schist on the southeast. A ledge of tourmaline quartz rock crops out in the branch about 75 yards southeast of the place where the tin lead crosses it. This ledge is composed of gray to smoky quartz penetrated by a large number of long, thin crystals of black tourmaline. In some parts the tourmaline composes about half of the vein.

Faires Prospect

Development work on the Faires property, a quarter of a mile southwest of the Falls prospect, consists of several pits and a 40-foot shaft with 200 feet of drifts, now badly caved in. A 10-foot pit at a place where rich float was found exposed a cassiterite-bearing pegmatite dike 3 feet wide striking N. 30° E. with a high northwest dip. The vein was cut on the 40-foot level by a crosscut from the shaft on the southeast. Here the pegmatite, it was reported, is about 3 feet thick and carries cassiterite. A drift to the northeast showed the pegmatite to be wider and to carry more cassiterite. Another pegmatite dike was prospected 33 feet southeast of this "vein" but did not carry cassiterite. The pegmatite from the underground workings is badly decomposed, most of the feldspar being kaolinized. The parts richest in cassiterite contain less feldspar and are harder. Some of the ore taken out was very rich, and in one section exposed the rock was estimated to carry about 10 per cent

cassiterite. The country rock is hornblende schist, badly decomposed. A tourmaline quartz vein is inclosed in the schist a few yards southeast of the pegmatite.

Other prospects were opened southwest of the main workings, on other outcrops of pegmatite. Cassiterite was found in some of these also, and in one of the exposures appears to be in promising quantity. About 300 or 400 yards southwest of the main deposit a large body of spodumene-bearing pegmatite over 40 feet wide crops out prominently in the north side of a small valley. No cassiterite was observed in this rock. Similar outcrops of spodumene-bearing pegmatite occur within half a mile to the southwest, but most of them lie northwest of the belt in which tin ore has been found.

Plonk Prospect

On the Plonk property a long trench was cut across the formations, exposing both spodumene pegmatite and cassiterite-bearing pegmatite inclosed in hornblende schist. The formations strike N. 35° E. and dip 75° NW.

Old Ledoux Prospects

Considerable prospecting has been done along the ridge adjoining and to the southwest of the Plonk property, first by Ledoux & Co. in 1888 and 1889 and later by the Blue Ridge Tin Corporation. At the northeast is an old crosscut trench, where little is to be seen at present. Next is a trench about 200 feet long and 5 to 20 feet deep along the east contact of a large pegmatite. At the surface the contact strikes N. 25° E. and dips 80° NW., but at a depth of 20 feet the dip is 60° NW. Coarse garnetiferous mica schist forms the footwall of the pegmatite. Cassiterite was found in a greisen-like phase of the pegmatite along the footwall. The cassiterite-bearing portion is from 1 to 3 feet wide and is rich in some places and poor in others. It is reported that a vertical diamond drill hole bored over 100 feet west of the "vein" cut 5 feet of ore at a depth of 275 feet. The pegmatite dike at this place is probably at least 25 feet wide. To the northwest are other large masses of pegmatite separated from one another by several feet of schist. These bodies do not crop out distinctly, and pegmatite bowlders have rolled between them, giving an appearance of one large deposit several hundred feet wide. Some of them carry considerable spodumene but apparently no cassiterite. The cassiterite-bearing mass is inclosed in mica schist, but most of the other masses are in hornblende schist.

About 50 yards southwest of the long trench a shaft 85 feet deep, called No. 1 by the Blue Ridge Tin Corporation, was sunk near a pit where good ore had been found. A 60-foot crosscut from the shaft cut three "veins," one of which carries cassiterite. These pegmatite veins

are in interlaminated hornblende schist and garnetiferous mica schist. Further southwest is a trench 100 feet long and 3 to 12 feet deep on a contact similar to that just described. This contact strikes about N. 25° E. and dips 80° W. Cassiterite was found in part of this trench, and some of the material was promising looking ore. A short distance to the southwest two shafts have been sunk, one on spodumene pegmatite. Cassiterite was reported in both of these shafts.

Near the end of the ridge a trench was made along the southeast contact of another large body of spodumene-bearing pegmatite, which carries cassiterite along the southeast wall. The wall rock on this side is chloritic mica schist.

About 200 yards west of this trench, on a knoll across a small valley, is another old shaft, 60 feet deep, in a large pegmatite dike carrying spodumene. A little cassiterite was found at this place and also at another pegmatite outcrop opened by two pits about 200 yards southwest. The inclosing rock is hornblende schist at both of these prospects.

Blue Ridge Tin Corporation Main Works

At the northeast end of the outcrops on the property of the Blue Ridge Tin Corporation a shaft 80 feet deep (No. 4) was sunk, with a 60-foot drift to the southwest on the 60-foot level. A 20-foot prospect shaft was sunk south of the main shaft. Two "veins" were found—one in the 20-foot shaft and the other along the northwest side of the drift on the 60-foot level. The material of these "veins" consists of schistose greisen-like pegmatite and is reported to be badly crushed in the underground workings.

About 200 yards to the southwest is shaft No. 5, 130 feet deep. Underground workings cut two "veins" carrying cassiterite. One of these veins that crops out 15 feet southeast of the shaft was cut a few feet from the shaft in a crosscut to the southeast on the 85-foot level and in the shaft near the bottom. This "vein" is said to contain fine grained ore at the surface but coarser ore underground. The outcrop of the other vein was not found, but the ore was cut in the crosscut on the 85-foot level. It is said to have been coarse grained and rich ore. Another cassiterite-bearing pegmatite body was opened by a 25-foot shaft about 60 yards west of the main shaft.

A large spodumene pegmatite mass about 15 feet wide crops out between shafts No. 4 and No. 5. Débris of cassiterite-bearing pegmatite or greisen was found near this mass, and a little cassiterite was observed in the spodumene-bearing part.

The country rock at these workings consists of interlaminated hornblende schist and bluish mica schist having a northeast strike and high to

nearly vertical northwest dip. The "veins" seem to be at least approximately conformable with the inclosing schist.

Placer deposits have been worked in the bottom land along the valley southwest and south of the mine. The ground favorable for this work is from 50 to 100 yards wide at the lower end and tapers northwestward to shoals where the tin lead crosses the stream. It has a length of over 200 yards. Water is available, and parts of the placer ground are reported to have been tested with encouraging results. At one time some of the alluvial material was hauled up an incline track to a concentrating mill on the hillside, but although several thousand pounds of concentrates were washed out the work was not profitable with such equipment.

On the hill on the southwest side of this same valley a 25-foot shaft was sunk and a 10-foot crosscut run. A body of spodumene pegmatite, 5 feet wide, was found inclosed in hornblende and chlorite schist. A little cassiterite is reported to have been taken out. In two prospects within half a mile southwest similar spodumene-bearing pegmatite masses were opened. They are in hornblende and chlorite schist. Cassiterite is reported to have been found in both. A mass of tourmaline quartz rock occurs about 10 feet southeast of one of these pegmatite masses.

Ross Prospect

At the old prospect two-thirds of a mile southeast of Crocker, opened by Capt. S. S. Ross in 1903, a pit was sunk on the southeast side of a body of pegmatite about 20 feet wide. This pegmatite is said to contain considerable cassiterite in a streak several inches thick along the southeast wall but only a few scattered grains within the mass. Bluish mica schist forms the wall rock, but 45 feet to the southeast there is a belt of hornblende schist. A vein of tourmaline quartz is inclosed in the hornblende schist about 50 yards southeast of the pegmatite.

Lincolnton Quadrangle

Prospects Along Chestnut Ridge

The Mauney Park prospect is on the south side of a small valley cutting eastward across Chestnut Ridge, about one mile north of the north edge of the town of Kings Mountain. The deposit is near some springs which have been walled up and around which the grounds have been cleared as a park. It was discovered by the presence of a number of bowlders of greisen, rich in cassiterite and weighing from 30 to 150 pounds each, loose in the surface soil. A small amount of prospecting was done during the "tin excitement" of 1904. This work consisted in clearing out undergrowth and digging pits and a crosscut trench. The

pits are on the north side of a small ridge pitching east and the trench is on the south side of the ridge, 65 yards due south of the pits.

The country rock consists of kyanite mica schist and gneiss with a narrow belt of hornblende schist close to the tin bearing pegmatite. The schists strike north and have a vertical dip, and the pegmatite is approximately conformable with them. The pegmatite exposed in one of the pits is nearly 8 feet wide. Of this width 2 feet along the west wall consists of cassiterite-bearing greisen. The remaining 6 feet of pegmatite is highly feldspathic and carries but little cassiterite. This portion of the dike is soft and crumbling owing to the kaolinization of the feldspar. The feldspar free greisen portion is fresh and hard and shows a few iron oxide and clay stains. Part of the greisen is rather fine grained, and part is coarse containing muscovite crystals an inch across. In places at least 10 per cent of the greisen is cassiterite, some of which occurs in crystals an inch long and half an inch thick.

Pegmatite was cut in the trench on the south side of the ridge, apparently in direct line with the cassiterite-bearing pegmatite on the north side. No cassiterite was observed at this place, however. From 20 to 30 yards east of this an outcrop of spodumene-bearing pegmatite extends in a west of north direction across the ridge. No cassiterite was seen in the prospects opened on this spodumene pegmatite.

Cassiterite-bearing greisen is found in a cultivated field a quarter of a mile due north of the Mauney Park prospect, on the west side of Chestnut Ridge. Bowlders of this rock have been plowed up, but no prospect work has been done.

The Horton shaft, 122 feet deep, was sunk in 1893 on the east side of Chestnut Ridge half a mile northeast of the Mauney Park prospect by residents of Kings Mountain. Crosscutting was started, and cassiterite-bearing pegmatite is reported to have been found. This prospect is not in line with the Mauney Park lead but is in line with other prospects on the east side of Chestnut Ridge and east of Long Creek Church. At one of these, on the land of J. J. Ormond, a quarter of a mile east of the north end of Chestnut Ridge, cassiterite-bearing greisen was found in surface bowlders and in a prospect shaft. A little cassiterite has been found between the Horton shaft and the Ormond prospect along the east side of Chestnut Ridge.

Ormond-Carr Prospect

The Ormond-Carr prospect is a quarter of a mile east of Long Creek Church. A shallow shaft and a few pits were made in a north-south direction along an outcrop of pegmatite. The country rock is hornblende schist of the Roan gneiss. A narrow belt of staurolite schist crops out a few yards east of the deposit. The formations strike about

north and have a high westerly dip, and the pegmatite is approximately conformable with them. The pegmatite exposed is from 5 to 8 feet wide and carries cassiterite in places.

Hovis Prospect

The M. V. Hovis prospect is 1⅔ miles N. 12° E. of Long Creek Church. Cassiterite is found in loose crystals and in small bowlders of greisen scattered over a field and along the public road. A 35-foot prospect shaft was sunk a few yards west of the road, and decomposed pegmatite was encountered in it, but no cassiterite was seen at the time of examination. The country rock is evidently chiefly hornblendic schist weathered to a dark-brown soil.

Ramseur Mill Prospect

The Ramseur Mill prospect is about a third of a mile east of north of the Hovis prospect, or nearly 2 miles east of north of Long Creek Church. A shaft and a trench were made here during the first tin excitement, and some very promising cassiterite-bearing greisen was thrown out. The country rock is hornblende schist with varied strike and dip. The attitude of the pegmatite is not plainly evident, but the trench made along the northeast contact showed this to have a N. 30° W. strike. The pegmatite body is large, at least 15 feet wide, and crops out through a distance of about 75 feet. The cassiterite was found in a greisen streak 1 to 2 feet thick along the northeast wall.

Jones Mine

The Jones mine is about 3½ miles N. 30° E. of Bessemer City. It was first prospected in about 1892 or 1893, but the principal work was done between 1903 and 1904. The following description is partly taken from a report by Graton,[1] supplemented by notes of D. B. Sterrett. The early workings consisted of a shallow shaft and some pits on a pegmatite vein striking north of west with a nearly vertical dip. At one place this vein was 2½ feet wide and very rich in cassiterite. About 70 feet west it contained only a small quantity of cassiterite, and 70 feet still farther west cassiterite was absent.

Later work was rather extensive. Shafts and trenches were made along the vein first opened through a distance of about 200 feet. A shaft 175 feet deep was sunk about 150 feet N. 70° W. from the west end of the workings along this vein, and still another shaft 150 yards west of this. A second pegmatite vein 100 yards south of the first one was opened by prospect pits through a distance of about 100 yards in

[1]Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 46-48, 1906.

a northwesterly direction. In all, about 500 feet of underground work is reported to have been done. A small amount of placer mining was carried on in the branch east of the deposit. A mill was erected at the mine, and a carload of concentrates is reported to have been shipped.

The deposits occur near the contact of interlaminated hornblende schist of the Roan gneiss and mica gneiss of the Carolina gneiss. The strike of these formations ranges from east of north on the east side of the deposit to nearly west near the middle of the workings and northwest near the west workings. The dip ranges from 50° N. to nearly vertical. The first vein opened cuts across the bedding of the country rock, having a north of west strike and a nearly vertical dip. Along the contact of this pegmatite the mica gneiss contains a quantity of small black tourmaline crystals and needles. Pegmatite also occurs in small offshoots from the larger bodies and in lenses and stringers near them.

The pegmatite mass is variable in character. In some places it has about a normal mineral composition. In others the feldspar is subordinate, or almost absent, and cassiterite may or may not be present. Some of the pegmatite from the 175-foot shaft contains spodumene. Where cassiterite is plentiful the pegmatite does not carry so much feldspar, and in places where there is more than 10 per cent of cassiterite feldspar is practically absent.

Some of the richest ore was found in the vein first opened. A small sample of ore from the earlier workings yielded cassiterite equal to about 5 per cent metallic tin when crushed and panned. Graton states that the average of all the pegmatite broken in the mine is said to have been about 0.7 per cent of metallic tin.

Stroup and Rayfield Prospects

Prospects were opened in 1904 along the boundary line between the places of Nora Rayfield and John Stroup, 2½ miles S. 60° W. of Landers Chapel, but these pits are now filled up. The country rock is hornblende schist, and a belt of kyanite gneiss lies a few yards west of the tin deposits. Cassiterite-bearing pegmatite was found in the prospects, but only a few pieces of this ore, of medium grade, were left on the surface at the time of examination.

Hastings Prospect

The H. P. Hastings prospect is about half a mile northeast of the Stroup and Rayfield prospects, or 2 miles S. 65° W. of Landers Chapel. It was opened by a 14-foot shaft and a crosscut trench. Cassiterite-bearing pegmatite was found on the surface for a distance of about

100 feet in a northeasterly direction. The country rock consists of interbedded hornblende schist and kyanitic mica gneiss, which strike northeast and have a high northwest dip. The pegmatite is approximately conformable with the bedding of the inclosing rock. The ore is medium grained and carries a large percentage of quartz, a little feldspar, mica, and fine cassiterite.

Baldwin and Allen Prospects

The prospects of J. Baldwin and J. R. Allen are a third of a mile northwest of the Hastings prospect, or 2 miles S. 73° W. of Landers Chapel. They are on opposite sides of the public road, the Baldwin prospect about 80 yards southwest of the road and the Allen prospect about 150 yards N. 55° E. from the Baldwin prospect. A 45-foot shaft was sunk at the Baldwin prospect, and a few blasts were made in the outcrop. Two pits, now partly filled up, were made at the Allen prospect.

The country rock is diorite and hornblende schist of the Roan gneiss. The schist strikes northeast and has a high northwest dip. The prospects are in lenticular shaped outcrops of spodumene-bearing pegmatite which forms a small oval knoll. These pegmatite outcrops are 10 to 20 feet wide and 50 feet or more long. Some of them are in line with one another, and others overlap at the ends. In texture the pegmatite is about medium-grained, the feldspar crystals ranging from less than 1 inch to 4 inches in thickness and the spodumene crystals being 1 to 2 inches long. The spodumene is mostly opaque and gray, but a few crystals with transparent yellowish-green portions were observed. The mica of the pegmatite is yellowish green and occurs chiefly in small crystals half an inch or less in diameter. The cassiterite is present in rather small grains and crystals scattered through parts of the pegmatite. Pieces of medium grade ore, 10 to 12 inches across, were left on the dumps. Cassiterite was not found in all the outcrops of spodumene pegmatite.

Four ledges of decomposed spodumene pegmatite are exposed in a space of 100 feet along the road and about 100 yards east of the tin bearing lead, but no cassiterite was seen in them.

Production

There has been little tin ore produced in North Carolina during the period covered by this report. In 1916 there was a little activity in the tin belt, but none was shipped. In 1917 some mill run tests were made on the property of the United States Tin Company near Lincolnton. This was not, however, put on the market.

MANGANESE

The declaration of a blockade of England and the coasts of her allies, by Germany in February, 1916, and a subsequent destruction of merchant ships have made hazardous the importation of the customary quantities of ferromanganese from England, and have increased the cost of obtaining ores from Brazil and India. Consequently, there has been an energetic search for nearby sources of ore.

While manganese has been found more or less sparingly in a great many areas throughout North Carolina, there are only a few where it gives any promise of occurring in commercial quantity. Up to 1917 there has not been more than a few car loads of mineral containing this metal shipped from North Carolina; and these were largely for experimental purposes. Since the outbreak of the European war, however, there has been an increased interest aroused in North Carolina ores, and some investigation has been made in regard to sources of supply in this State. The principal occurrences of manganese are:

In Cherokee County, about 2½ miles above the mouth of Low Creek, where a very pure manganese ore (pyrolusite) was found. This ore assayed 58.36 per cent manganese.

In Madison County, on the east side of Shut-In Creek, about 2 miles above its mouth, a 4-foot seam of manganese ore is reported to have been found on the land of J. J. Fitzgerald. The ore is psilomelane and of good quality. Nothing is known regarding the extent of the deposit.

In Catawba, Lincoln and Gaston counties there is a belt of manganese slates extending from near Anderson's Mountain in Catawba County to the South Carolina line. While these slates average comparatively low in manganese, portions of them carry a considerably larger percentage of this metal, and may upon investigation be shown to carry a sufficient percentage to make them commercial deposits.

Associated with the magnetites of Ashe County, are ores containing a high percentage of manganese. The most promising deposit is the Piney Creek mine, which is one of the Ballou properties.

In Surry County manganese ore of very good quality has been found in some quantity on the farm of R. E. Freeman, near Dobson.

In Transylvania County, about 7 miles northeast of Brevard, there is a deposit of manganese ore associated with limonite, this latter carrying a trace to several per cent of manganese. Assays of this ore have shown it to contain from 22 to 57 per cent manganese.

Another deposit, located in Beaverdam township, Haywood County, 2 miles southwest of Canton, contains manganese ore of some promise.

In the summer of 1917, Mr. Clarence S. Ross, Geologist of the United States Geological Survey, made an investigation of certain of

the manganese deposits of North Carolina for the State Survey, and below are given the results of this investigation.

"*Clay County:* A manganese prospect is located 8 miles east of Hayesville, Clay County, on the property of Savage Brothers and the Hiawassee Lumber Company. Both pieces of property are controlled by Savage Brothers, of Murphy. It is 27 miles to Murphy, but a railroad has been graded to Hayesville, 8 miles away. The property itself is several miles from any road whatever at present. The elevation is between 2,500 and 3,000 feet. Good timber covers all the region. There is a belt of manganiferous slates extending from a cove near the headwaters of Mill Branch Creek on the south side of the Vineyard Mountain southwest almost to Shooting Creek, a distance of about two miles. The strike is S. 30° W., and the dip about 45° East. The width varies from 300 feet up to nearly one-fourth mile. The property has been prospected by Savage Brothers by 15 cross trenches. No depth over ten feet has been reached. The surface has been rather completely prospected, but nothing is known about the deposit in depth. Near the north end there are seams of manganese ore in the slates, but they do not occur in amounts to constitute a source of ore. Near the south end there is much float of hard black siliceous manganese bearing slate, or manganiferous sandstone. This is the so-called hard ore, but it is too low grade to constitute ore. It does not seem advisable for Savage Brothers to continue work on this prospect, as it offers very little encouragement. The slates in this region are very similar to those of the belt in the central part of the State running through Gaston, Lincoln and Catawba counties. It is not as rich in manganese as the deposits near Kings Mountain, which have not been a paying proposition to date.

"*Cleveland County*: The manganese deposit near the base of Kings Mountain was examined. Here the belt of manganiferous slates is about 1,000 feet wide. Nearly a thousand feet of trenches and other pits have been made. The deposit at this locality is now well exposed to a depth of 20 feet. A car load of the ore has been shipped for experimental purposes. The slates exposed in the trenches vary from a light gray micaeous slaty schist to a nearly black slate quite high in manganese. None of the slates are manganese ore, however. The best ore is derived from seams and stringers that cut the slates in all directions; but which most often follow the schistosity roughly. These vary from a few inches to a few feet in width. Usually they are only a few inches wide, and none were exposed more than a foot wide. The ore shipped consisted of slaty material that had been enriched, probably by leaching of the siliceous material, and possibly by redeposition of manganese oxide in the place of this material. Some of the best ore is a very pure pyrolusite in the form of nodules and botryoidal masses, but this portion of the material shipped was small. Some is composed of alternating bands of manganese oxides and quartz. Even though the material shipped is high grade enough to be an ore of manganese, it would constitute only a small percentage of the material removed. The stringers that can be considered ore are all small and nonpersistent.

"*Surry County:* A manganese deposit belonging to Mr. R. E. Freeman is situated 12 miles west of Mount Airy, Surry County. Active prospecting is being carried on by a competent man. Several trenches have been cut

4 to 8 feet deep and a pit has been sunk 12 feet. The deposit as developed is 50 feet wide and 150 feet long. One wall is mica schist and the other quartzite with a little fine grained soft manganiferous slate between. The deposit is almost entirely composed, however, of pyrolusite cut by bands and stringers of quartz. Some of the quartz is in the form of dark brown cherty material, but most of it is crystalline quartz. There are many masses of splendid ore, and masses of good ore weighing 100 pounds are on the dump. Because of the amount of quartz and the way in which branching stringers of quartz cut good ore, it will require very careful hand cobbing to produce a marketable product. As at present exposed, not more than 25 per cent of the material taken out can be put in shape to ship. High grade material can be produced, however. It is only a question whether the body is large enough and the ore can be hand cobbed closely enough to make it pay. It is to be hoped that further development will disclose ore freer from silica. Workings are so shallow that nothing can be stated about the conditions in depth. It seems to be Mr. Freeman's intention to continue work and make a trial shipment. The ore at this place is very much the best that I have seen so far in my work. It is far better than that that was shipped from Kings Mountain, I should judge. About 150 yards northeast of the point where this work has been done there is another outcrop which has not been investigated, but which indicates that there is a true lead running parallel to the structure of the country rocks. It is stated that there is a belt running northeast for a number of miles along which there are indications of manganese, but no prospecting has been done, and nothing can be learned as to the nature of the belt without some work."

Production

There was a small production of manganese in 1917, but as this was made by one producer the figures could not be given and are included under "Miscellaneous" in the general mineral table, page 10.

PYRITE

Pyrite is another mineral which has come into tremendous importance because of the war. There has been a great deal of search for properties which would produce pyrite in sufficient quantity to warrant opening them up. The Oliver pyrite mine, located about 6 miles from Dallas, Gaston County, is the principal mine in North Carolina. The pyrite occurs in seams and lenses which have been continuous along the strike and in depth, but with varied thicknesses. It is reported that the Federal Pyrites Company of Gastonia has been organized to work this property.

Mr. James Frame claims to have a pyrite mine near Otto, Macon County. He states that the property is located within a mile and a half of the railroad; that the ore is similar to the Spanish lump, and is practically free from gangue. The vein is 10 feet wide and has been proven for a distance of one-half mile.

Production

There was no production of pyrite in North Carolina during the period covered by this report.

CHROMITE

Chromite is one of the minerals the production of which has been affected by the present war. This has caused renewed interest in the deposits of this mineral in this country and is directing attention to the North Carolina deposits. The occurrence of chromite is in the peridotites and allied igneous basic magnesian rocks, or in serpentines that have resulted from the alteration of these.

The mining of chromite in this country has always been attended with considerable uncertainty on account of the pockety nature of the deposits; for chromite is not found in veins but in pockets or bunches of varying dimensions, which may or may not be connected with one another and are limited in extent; so that with the exhaustion of a particular pocket of chromite there will often be more or less dead work to be done before another is encountered. Usually no estimate can be made regarding the amount of chromite on a property beyond that which is exposed by the actual work done. The fact that ten tons or ten thousand tons have been taken out of one pocket does not signify that it is still a good deposit, but if a certain pocket has been productive of a large yield this would serve as a strong indication of the existence of other pockets near by. Yet if a deposit of this mineral is found near the contact of peridotite and other country rock, and if this peridotite formation is very extensive and the chromite is found in considerable quantity, there is a probability that large deposits will be found in the area.

While chromite is found almost universally associated with the peridotites of North Carolina, it is only in a few localities that it occurs in quantity. One of the most promising deposits in the State is in Yancey County at Mine Hill on Mine Fork of Jack's Creek, alongside of the Bakersville road, five miles north of Burnsville, county seat. The ore occurs in a large peridotite formation which outcrops on both sides of the road. What little work has been done on this deposit gives indication that chromite occurs in quantity. The C. C. & O. Railroad from Erwin, Tennessee to Green River Station, North Carolina, runs within three and a half miles of the property. An analysis of a selected sample of this chromite showed 58 per cent of chromic oxide, but judging from the character of the ore, a 52 per cent ore can probably be readily obtained by hand picking and cobbing. The property is owned by J. Bis Ray of Burnsville.

Associated with the large peridotite area or formation in the vicinity of Webster, Jackson County, chromite has been found quite abundantly at a number of points near the contact of the peridotite with the country rock. The principal work has been done on the lands of David Schneider, Joseph Hooker, Lawrence Buress, Alf. Wilson, James Ashe and Daniel Fulbright, all of Webster, North Carolina. The work done shows the presence of a considerable amount of chromite, but it is not sufficient to demonstrate whether it is to be found in sufficient quantity to make profitable mining. These chromite deposits would be from three to five miles from the railroad.

Another property that is being devoloped is on Big Ivey Creek in Buncombe County, about 16 miles northwest of Asheville, and 9 miles from the railroad. There is considerable chrome sand on the property, which is readily concentrated, and, as reported, the concentrates contain 54.09 per cent of chromic oxide. The rock ore, which had been hand-cobbed, gave on analysis 48.78 per cent of chromic oxide. This property is being developed by Mr. F. L. Plaisance of Asheville.

A promising deposit of chromite occurs in the Balsam Gap peridotite area and is located on both sides of Dark Ridge Creek about 175 yards to the south of the Dark Ridge trestle of the Murphy branch of the Southern Railroad. A number of open cuts and pits have been made which show the presence of chromite in some quantity. There is a large quantity of float ore in the vicinity which, with a nearness to the contact of the peridotite and gneiss and the pockets and veins already uncovered, point to this locality as a promising one for further development; and its nearness to the railroad is also greatly in its favor.

All North Carolina ores are high grade, but the existence of large deposits have not as yet been conclusively shown; but the four localities mentioned above are worthy of further investigation.

Production

There was a production of chrome ore in North Carolina during 1917 made by the Carolina Chrome Company at Webster, Jackson County. This was shipped to Philadelphia.

ABRASIVE MATERIALS

Among the list of materials used for abrasives, North Carolina can furnish Corundum and Emery, Garnet, and Millstones. Of these natural abrasives, North Carolina is better supplied with corundum than

any of the other States, there being over 60 corundum localities known in the State, which extend over a considerable area. At the present time, however, it is known to occur in commercial quantity in only four counties: Clay, Macon, Jackson and Transylvania. These corundum deposits should be of great economic importance to the State. The principal mines are the Corundum Hill at Cullasaja, and the Mincey at Ellijay, Macon County; the Buck Creek or Cullakeenee, Clay County; the Socrates, Bad Creek, and White Water near Sapphire, Jackson County; and the Burnt Rock, and Brockton in Transylvania County. The corundum at all these localities is associated with peridotites. At the Scaly Mountain deposit in Clay County the corundum is associated with quartz schist; and at the Caney Creek mine in Jackson County it occurs in chlorite schist. Besides these, there are a number of other deposits that have been developed, and others that are promising prospects, such as the property of the North Carolina Corundum Company at Little Buck Creek, Macon County; a deposit in Woodfin Cove, Balsam Mountain, near Hall, Jackson County; the Corbin and Grimshaw property near Montvale, Transylvania County; and the Carter mine in Madison County, near Democrat, Buncombe County.

The corundum and emery deposits are described in detail in Volume I of the publications of the North Carolina Geological and Economic Survey.

Garnet is another abrasive material that is mined to some extent in North Carolina. There are many localities in the State where garnet occurs in commercial quantity, but most of these are nonproductive on account of their distance from railroad transportation. The only deposit which is producing at the present time is the deposit near Shooting Creek, Clay County, owned by N. N. Rogers. The rock is crushed and concentrated on Bartlett concentrating tables.

The millstones or buhrstones produced in North Carolina are made mostly of garnet which is quarried and made into millstones. This is obtained from near Faith and Salisbury, Rowan County. The millstones are used mostly for grinding corn and oats. At Parkewood, Moore County, a quartz conglomerate was quarried in 1914 and made into millstones. These stones were known as the North Carolina grit.

Production

In 1913 the only abrasives produced were garnet and millstones. The Blue Ridge Garnet Company produced garnet at Shooting Creek,

Clay County. It is reported that all of the 1913 product was shipped abroad. Three operators reported productions of millstones in 1913, all of these being from near Salisbury, Rowan County.

In 1914 three operators reported productions of millstones, two from Rowan County, and one from Moore County.

In 1915 two operators reported productions of millstones from Rowan County, this being the only abrasive produced in that year.

In 1916 there were two operators who reported a production of millstones in Rowan County and one production of garnet was reported from near Willetts, Jackson County, by the Great Ruby Mining Company.

In 1917 North Carolina again comes into prominence as an abrasive producing state. There were three mines which produced corundum and emery, two in Macon and one in Jackson County, the combined output being 820 short tons, valued at $67,461. There was a production of garnet from Shooting Creek, Clay County, during this year and one operator from Rowan County reported a production of millstones.

In the table below there is given the total value of the production of abrasives from 1901 to 1917, inclusive:

PRODUCTION OF ABRASIVE MATERIALS, 1901—1917, INCLUSIVE.

Year	Corundum		Garnet		Millstones		Total Value
	Quantity	Value	Quantity	Value	Quantity	Value	
	Tons		*Tons.*		*Pairs.*		
1901	325	$ 48,840	775	$ 43,000	----------	$----------	$ 91,840
1902	----------	----------	260	10,040	50	1,425	11,465
1903	----------	----------	*403	12,250	63	902	13,152
1904	----------	----------	*202	6,586	208	6,500	13,086
1905	†1,150	9,000	----------	----------	196	2,652	11,652
1906	----------	----------	----------	----------	205	4,100	4,100
1907	----------	----------	----------	----------	----------	----------	‡15,469
1908	----------	----------	----------	----------	----------	4,052	4,052
1909	----------	----------	----------	----------	----------	9,188	9,188
1910	----------	----------	----------	----------	----------	7,981	7,981
1911	----------	----------	----------	----------	----------	----------	§9,773
1912	----------	----------	----------	----------	----------	----------	*a*10,914
1913	----------	----------	----------	----------	----------	8,772	8,772
1914	----------	----------	----------	----------	----------	5,164	5,164
1915	----------	----------	----------	----------	----------	12,002	12,002
1916	----------	----------	----------	6,600	----------	7,889	14,489
1917	820	67,461	----------	----------	----------	2,875	*b*70,336

*Including production of corundum. †Including production of garnet.
‡Including corundum, garnet, and millstones. §Including garnet and millstones.
*a*Including garnet, millstones, and small quantity of feldspar, said to have been used for abrasive purposes. *b*One producer.

Producers of Abrasives

CORUNDUM AND EMERY

Frank Grant, Westfield, Mass. Mines, Macon County, North Carolina.

Hampden Corundum Wheel Co., care W. P. Leshure; Corundum Hill Mine, Cullasaja, Macon County, N. C., and Springfield, Mass.

Great Ruby Mining Co., care Silas A. Jones; Willets, Jackson County, N. C.

GARNET

Blue Ridge Garnet Co., care N. N. Rogers & Son, Shooting Creek, Clay County, N. C.

MILLSTONES

B. E. Eagle, Salisbury, N. C., R. No. 3.

Fisher & McCombs, Salisbury, N. C., R. No. 3.

J. T. Wyatt, Salisbury, N. C., R. No. 3.

MICA

For many years North Carolina has led in the production of mica in the United States. The industry commenced about 1867 or 1868, and in a few years was in a flourishing condition. Mica mining began in the mountain counties and has persisted there to the present. Good mines have been worked intermittently in several counties of the Piedmont plateau, but the bulk of the production has come from the northwestern side of the Blue Ridge. In the Mountain region, mica deposits have been worked in nearly every county from Macon and Jackson on the southwest to Ashe County on the northeast. Mitchell and Yancey Counties have probably been the largest producers, but Macon, Jackson, Haywood and Ashe counties have also been important. In the Piedmont region large productions of mica have come from Cleveland, Gaston, Lincoln and Stokes counties.

A feature of mica mining in North Carolina is that much of the output is furnished by small mines or prospects worked intermittently by farmers at times when crops do not require their attention. A number of large mines are also operated more or less regularly and yield much fine mica. Smaller quantities of mica are obtained more or less as a by-product during the mining of kaolin and feldspar. A part of the output of sheet mica of small ores is obtained from the dumps of old mines, but most of the dumps have now been pretty thoroughly worked over.

The greater part of the mica is handled by several large companies, most of whom purchase from the small mines, although some companies both operate their own mines and also purchase from others. Generally, the mica is brought to an advanced stage of preparation for the market before being shipped from the State. Part is split, closely trimmed, graded as to quality and size, and is then shipped for final

manufacture; part is trimmed or manufactured into patterns ready for use in the different trades. Only a small part of the sheet mica mined is shipped without being either manufactured or carefully graded. The bulk of the scrap mica is ground in the State. Small trimming plants for the first sorting of the roughly mined mica are scattered over the mica region and at many of the mines. Well equipped trimming plants are located at Asheville, Plumtree, Spruce Pine, and Penland. Mica grinding mills are located at Asheville, Plumtree, Spruce Pine, and Micaville.

Uses*

"The different uses to which mica is put depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades and in insulation.

"Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo electric machinery, electric light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves and for making lamp chimneys and lamp shades. It is also used in spectacles, automobile shields, phonograph diaphragms, in windows where glass would be broken, and in lantern transparencies.

"Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerin in the manufacture of "mica powder," in tempering steel; to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings; and as a filler for various products. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts is indicated in a recent Geological Survey report.[1]

"It is understood that sheet mica has come to be of importance as a war mineral through its use abroad as windows in masks worn for defense against asphyxiating gases, and for other uses where a transparent, noninflammable, nonshattering material is necessary, as in automobile goggles and in windows for armored cars.

"Several trade names have been given to the mica products described below.

"Micanite is a term applied to a mica board made from many small, thin sheets of mica, which are fitted together and built up by successive layers that are cemented with shellac and then subjected to pressure under heat to dry out the shellac. Large sheets thus made are suitable for many electrical purposes.

---

*Mica in 1916, by Waldemar Schaller, Min. Res. U. S. G. S. 1916. Part II, pp. 291-308.
[1]Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite, by George Steiger: U. S. Geol. Survey Bull. 620, pp. 227-235, 1916.

"Silberglimmer (silvery mica) is muscovite which has been heated to a sufficiently high temperature to make it softer and opaque and silvery in appearance. It is also known as annealed mica and finds a use in certain parts of electric apparatus.

"Micarta is an artificial mica product developed by the Westinghouse Electric & Manufacturing Co., of Pittsburgh, Pa., and is intended to take the place of hard fiber, glass, porcelain, hard rubber, builtup mica board, rawhide, molded compounds for use in commutators, bushings, brushholder insulation, noiseless gear blanks, conduits for wiring spools for spark coil and magnet windings, wireless coil separators, and water-meter disks. Micarta is a tan colored, hard, homogeneous material that can be sawed, milled, turned, and threaded. Thin sheets can be punched, and it is claimed that it will not warp, expand, or shrink beyond very small limits. Two grades of micarta are made. One, known as bakelite micarta, is infusible and will resist heat to a point at which carbonization of some of the ingredients takes place. It is insoluble in nearly all ordinary solvents, such as alcohol, benzine, turpentine, and weak acid and alkali solutions.

"Micamima, prepared by the Crawford Mica Co., of Crawford, Neb., is a coarsely ground mica used in the manufacture of concrete facing material; mixed with other minerals it is used to give the effect of natural rock, and it may be used for different decorative purposes.

"Micolith, prepared by the Texas Mica Co., of Pecos, Tex., is another similar product used to give the effect of natural rock to concrete facings.

"Tungash, as the Denver Mining & Manufacturing Co., of Denver, Colo., calls its product, is a bronze-colored, metallic looking material of value for decoration. The crude biotite mica, altered and hydrated, has a dull greenish-black appearance when mined. On being heated it expands to a light product, which has a rich golden bronze color and a decidedly metallic luster.

"Clinomica is the name given by the American Mica Co., 52 Broadway, New York, to its ground clinochlore, a mineral of the chlorite group. Clinomica possesses essentially the qualities of ground mica, and is used as a dusting material in the rubber and composition roofing industries, for paints, cements, lubricants, molded electric insulation, and as a filler for various products.

"Rimco is mica ground by a nonmetallic process by the Richmond Mica Co., Richmond, Va., for use as a tire powder. It is also used by manufacturers of oils and lubricating greases."

Localities

Mr. John E. Smith, in the summer of 1917, visited several mica localities and made the following notes:

Cleveland County: Wm. H. Blanton, Lattimore, dealer and producer. Mr. Blanton gives his entire time to the mica business and buys nearly half of the material marketed. From August, 1916, to February 1, 1917, he sold block mica only. Since the latter date he has been buying and producing sheet mica, punch mica, scrap mica, etc. In July, 1916, he leased 2 acres of land located six miles southeast of Lattimore, that had been bought by J. E. Burleson and operated continuously until August, 1917. The mica

is taken from a pegmatite dike and the mica removed from an open cut along the dike. The cut is about 200 feet long, 47 feet deep, 4 to 10 feet wide, averaging about 6. When seen, the water level in the cut was about 20 feet below the surface. Nearly $10,000 worth of mica was taken from this cut.

Method of working: Blasting, using dynamite sticks, sledge, crowbar, pick, etc., in the deeper parts. Hoisted by hand windlass, pump, double stroke hand.

Sizes	Production	Price Per Pound
1½ x 2 in.	200 lbs. per mo.	$0.40 to $1.00
2 x 2 in.	100 lbs. per mo.	.65 to 1.25
3 x 2 in.	150 lbs. per mo.	1.00 to 1.65
3 x 3 in.	50 to 75 lbs. per mo.	1.45 to 1.90
3 x 4 in.	40 lbs. per mo.	1.75 to 2.40
3 x 5 in.		2.15 to 3.00
4 x 6 in.		2.75 to 3.00
6 x 6 in.		3.00 to 4.00

Other sizes produced are 6x8, 8x10, 12x12, 12x14, and 12x16. Punch mica produced, about one ton per month, sold at 5c to 10c per pound. The best production occurred in March and April with second best in July and August.

Cleveland County, Lattimore. Five and a half miles southeast of Lattimore, on land owned by C. J. Hamrick, and rented from him by W. H. Skinner and Bud Weathers, a mica mine is being worked by the renters. The mica occurs in a pegmatite dike 2 to 4 feet wide, and was opened in July, 1917. At present, it has been worked to a depth of 11 feet along a distance of about 20 feet, and is yielding good mica (muscovite). This dike is very nearly vertical. On the land of Mr. Green, nearby, some mica has been taken, in which the veins dipped at a steep angle and consequently were not worked very deeply or thoroughly.

Blanton and Harrel began business about June 1, 1917, and are mining as well as buying.

At the Isinglass Mill Mica Mine, 3 miles north of Rutherfordton, N. C., an attempt was made 2 or 3 years ago to obtain mica by working over the dump and saving the material wasted in it. In this, 2 shaft screens were employed. They were cylindrical, made of poultry netting having about 1½ inch meshes, the poultry netting being doubled to form the cylinder. Only a small portion of the dump was worked when the operation was discontinued. This attempt was evidently unsatisfactory, as the work has not been taken up again since.

Jackson County, near the railroad, between Beta and Addie, an attempt to obtain mica by rescreening the dump from an old mica mine was made. The screen was about 3 feet by 5 in size, placed on an incline and used in the same way in which sand is screened for mortar. This was evidently a failure, as but little material was reworked.

Macon County: Polly Roby mica mine, near Iola; G. W. Grindstaff, superintendent. Shaft 50 feet deep, 7 feet in the clear, walled with hewed timbers. Tunnels also carefully timbered. Vein 18 to 24 inches wide on each side of a wide quartz center. This vein or dike is irregular in direction and extent. The company is sinking a new shaft about 20 feet from the bottom of the 50-foot shaft; that is, below the 50-foot level. The tunnels are 6 feet high. Much water is encountered, running about 60 gallons per minute. This requires pumps to be kept in operation day and night; consequently the company employs sufficient men to operate day and night shifts.

The equipment consists of 3 boilers, 35, 6 and 10-horsepower; 20-horsepower hoist; 3 pumps, Fairbanks, Worthington (capacity 100 gallons per minute), Morse (capacity 500 gallons per minute); repair shop; tool houses, etc. Wood is used as fuel at present, as the cost of coal would be $7.75 per ton. 23 men are employed and the product is about 2,000 lbs. per week, all grades. It costs the company 40c a ton to have this mica hauled to Sylva, Jackson County.

This company is also operating the Buoy Mine, not far from Herman Dean's store, on the road between Franklin and Eulalie.

Production

There is given in the following table the approximate value and distribution by counties of the production of mica for the years 1911 to 1917, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA 1911—1917, INCLUSIVE, BY COUNTIES.

County	1911	1912	1913	1914	1915	1916	1917
Ashe	$ 4,000	$ 5,300	$ 3,500	$ 1,500	$ 2,500	$ 2,380	$ 8,700
Avery			26,659	24,770	68,111	83,200	77,050
Buncombe	255	531	520	340		800	1,200
Cleveland	1,000	2,300	3,100	2,700	3,500	500	1,034
Franklin						200	1,100
Haywood	4,000	5,732	6,241	4,780	9,000	38,000	29,840
Jackson	10,875	25,743	51,366	45,000	40,634	22,300	59,900
McDowell	400	540	540	420	500	900	1,500
Macon	54,800	53,823	50,322	36,000	238	67,800	60,162
Madison	870	1,400	1,200	500	500	400	2,000
Mitchell	134,745	147,430	108,430	69,420	109,202	75,000	126,05[illegible]
Rutherford						500	3,100
Stokes	130	200	535	240	500		
Swain						2,500	10,50
Transylvania	1,800	2,800	2,300	1,100	1,060	2,300	3,100
Watauga		100	700	500	500	800	2,200
Yancey	4,200	10,650	12,500	8,000	64,348	125,000	189,869
Totals	$217,075	$256,549	$267,913	$195,270	$300,593	$422,580	$ 577,341

The next table gives the value of the total production of mica, including both sheet and scrap, for the years 1900 to 1917, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA, 1900—1917.

Year	Sheet Value	Scrap Value	Total Value
1900	$ 65,200	$ 36,262	$ 101,462
1901	79,849	14,200	94,049
1902	81,653	2,219	83,872
1903	86,300	2,400	88,700
1904	100,724	3,410	104,134
1905	100,900	3,375	104,275
1906	205,756	11,940	217,696
1907	209,956	15,250	225,206
1908	114,540	13,330	127,870
1909	122,246	26,178	148,424
1910	193,223	37,237	230,460
1911	187,496	29,579	217,075
1912	219,874	36,675	256,549
1913	230,674	37,239	267,913
1914	171,370	23,900	195,270
1915	266,650	33,943	300,593
1916	380,700	41,880	422,580
1917	543,207	34,134	577,341

For many years North Carolina has been the largest producer of mica in the United States. In order to show the ratio of the production of mica in this State to the total in the United States, and the comparison of these figures with the value of the imports of mica, there is given in the table below figures covering these points for the years 1903 to 1917, inclusive:

PRODUCTION OF MICA IN THE UNITED STATES AND IN NORTH CAROLINA AND THAT IMPORTED INTO THE UNITED STATES FROM 1903 TO 1917.

Year	Production in N. C., Value	Production in U. S., Value	Import Value
1903	$ 88,700	$ 143,128	$ 317,969
1904	104,134	120,316	263,714
1905	104,275	178,588	403,756
1906	217,696	274,990	1,042,608
1907	225,206	392,111	952,259
1908	127,870	267,925	266,058
1909	148,424	280,529	618,813
1910	230,460	337,097	725,823
1911	217,075	355,804	502,552
1912	256,549	331,896	755,584
1913	267,913	436,060	943,783
1914	195,270	329,956	629,484
1915	300,593	428,769	692,269
1916	422,580	594,391	1,071,356
1917	577,341	757,346	1,430,048

Producers, Buyers and Owners of Mica Properties

A great deal of mica is mined in a small way by farmers in the mountain coves and sold to stores or companies or agents who buy for companies located within or outside of the State. Many of the companies located within the State mine a good deal of mica and also buy from these smaller producers. The following is a list of those who reported a production in 1917:

Asheville Mica Co.....Biltmore, N. C.
J. W. Autrey, (Mitchell and Yancey Counties) .....Harvard, N. C.
W. W. Avery.....Plumtree, Avery County, N. C.
R. S. Ballew & Co.....Celo, Yancey County, N. C.
J. A. Bartlett.....Spruce Pine, Mitchell County, N. C.
Frank Bennett .....Celo, Yancey County, N. C.
M. D. Billings.....Franklin, Macon County, N. C.
A. W. Bitner.....Burnsville, Yancey County, N. C.
Edward Blake.....Newdale, Yancey County, N. C.
J. Boyd Bland.....Plumtree, Yancey County, N. C.
John A. Bowditch.....Busick, Yancey County, N. C.
W. N. Bryson.....Cullasaja, Macon County, N. C.
Mark W. Bryson.....Gay, Jackson County, N. C.
A. Buchanan.....Spruce Pine, Mitchell County, N. C.
H. R. Buchanan.....Plumtree, Avery County, N. C.
Moses L. Buchanan.....Spruce Pine, Mitchell County, N. C.
J. E. Burleson Mica Co.....Spruce Pine, Mitchell County, N. C.
Carolina Mineral Co.....Penland, Mitchell County, N. C.
H. F. Carpenter.....Spruce Pine, Mitchell County, N. C.
Clinchfield Products Corporation.....120 Broadway, New York
Mines in Mitchell County, N. C.
J. L. Cook.....Spear, Avery County, N. C.
C. C. Cunningham.....Franklin, Macon County, N. C.
Elk Mining Co.....Plumtree, Avery County, N. C.
J. B. Ewing.....Boonford, Mitchell County, N. C.
W. T. Fonts and J. A. Ray.....Franklin, Macon County, N. C.
Intermont China Clay Co.....Bandana, Mitchell County, N. C.
Dr. Chas. H. Gifford.....97 Central Park, West,
New York, N. Y.
H. D. Grindstaff.....Toecane, Mitchell County, N. C.
E. C. Guy.....Newland, Avery County, N. C.
J. L. Hall.....Newdale, Yancey County, N. C.
F. O. Havener.....Franklin, Macon County, N. C.
Haywood Lumber and Mining Co.....Waynesville, Haywood County, N. C.
D. N. Howell.....Boonford, Mitchell County, N. C.
J. E. Howell.....Bakersville, Mitchell County, N. C.
J. T. Moore.....Franklin, Macon County, N. C.
Mountain State Mica & Mining Co.....Ardmore, Pa.,
Mines in Mitchell County, N. C.

Geo. W. Owens.....Greenmountain, Mitchell County, N. C.
E. H. Patrick.....Plumtree, Avery County, N. C.
E. Peltz Mica & Milling Works.....Newdale, Yancey County, N. C.
J. R. Penland.....Vixen and Burnsville, Yancey County, N. C.
M. H. Putman.....Bandana, Mitchell County, N. C.
John E. Rickman.....Iotla, Franklin County, N. C.
William Robison.....Micaville, Yancey County, N. C.
E. M. Robinson.....Bandana, Mitchell County, N. C.
N. N. Silver.....Micaville, Yancey County, N. C.
R. W. Sparks.....Boonford, Mitchell County, N. C.
Robert A. McDonald.....Sylva, Jackson County, N. C.
Lea Whetstine, Son & Co.....Celo, Yancey County, N. C.
General Watkins.....Cullasaja, Macon County, N. C.
Lee F. Wild.....Sylva, Jackson County, N. C.
Wilson and McNeill.....Burnsville, Yancey County, N. C.
W. W. Wiseman.....Bakersville, Mitchell County, N. C.

QUARTZ

Quartz, an oxide silicon, or, as it is sometimes commercially called, silica, or silix, is one of the commonest minerals and is very widely distributed in nature, being a constituent of many of the crystalline rocks and the main constituent of all sandstones. It is also found in quantity at widely varying localities, notably as a constituent of pegmatitic dikes. The uses of this mineral are quite varied, it being used in the manufacture of paste for wood finishing; in the manufacture of pottery and tile; sandpaper, and certain scouring soaps and powders; in the manufacture of a wood filler; glass; and in certain instances it is mined for a flux in copper smelting. When it is colorless and perfectly transparent, it is of considerable value for cutting into spheres, cubes, and other forms for ornamental purposes. There are also many varieties of quartz which are of value as gems.

There are large deposits of quartz in western North Carolina, many of which are associated with mica, and some of which should be available for many of the purposes enumerated above. As a by-product in mica mining, its cost of production would simply be for grinding, and with favorable transportation rates, it should be able to compete with quartz produced in other localities.

Two miles south of Murphy, Cherokee County, on the farm of J. T. Tait, a vein of quartz is being worked. This vein is reported to be 80 feet high, 25 feet wide, 18 feet of which is quartz. The quartz is shipped to Ducktown, Tenn., and sold as a fluxing material.

The Oliver mine, near Mount Holly, Gaston County, has been operated steadily for the past four years. Owing to the fact that there

have not been over two producers of quartz in any of the years covered by this report, the production is included under "Miscellaneous" in the general mineral table, page 10.

BARYTES

The mineral barytes does not usually occur in well defined veins, except when an accessory mineral in certain metallic veins; but it is more often found in a series of pockets, lenses, or seams of varying dimensions. These are more or less in line, often following the dip of the rock with which they are associated; and this rock is, in many cases, a limestone.

Barytes (barite or barium sulphate) is used chiefly in making mixed paints, in which white, ground, and water float barite, are employed as a pigment. Ground barite is also used in the rubber industry and, to some extent, by the makers of heavy glazed paper and ink. Lithopone, a chemically prepared white pigment, consisting of about 70 per cent barium sulphite and 30 per cent zinc sulphide, is one of the chief constituents of the "flat" wall paints so extensively used in office buildings and hospitals, replacing the less desirable paper and calcimine wall finishes.

Since the beginning of the war, a barium chemical industry has been established in the United States to supply barium carbonate, nitrate, chloride, chlorate, hydrate, and binoxide, which were formerly imported largely from Germany. The barium chemicals have a wide variety of applications, perhaps the most important of which are the use of barium binoxide in the preparation of hydrogen peroxide; that of barium chloride as a water softener, and that of various salts in the manufacture of optical glass.

Most of the operating mines in North Carolina are in the vicinity of Stackhouse, Madison County. It is reported, however, that in 1915 and 1916 there was some development work on the barytes mine near Bessemer City, Gaston County.

On the Kings Mountain ridge, which runs in a southwesterly direction from Bessemer City for several miles, there are a number of openings on lenticular veins of pyrite which are closely associated with sericitic schists. The principal mine is the Lawton, 5 miles south of Bessemer City, at the south end of the ridge. Most of the barite bearing veins are east of the highest part of the ridge and lie parallel to the schistosity of the enclosing rocks. The barite is granular and is associated with quartz, galena, and sphalerite.

The Madison County barite belt is about 5 miles long; it extends from Bluff, on Spring Creek, in a northeast direction through Doe Run

and across French Broad River near Sandy. In this belt which is close to a large thrust fault are enfoldent remnants of Cambrian quartzite (snowbird formation) in the Archean granite, which is the general country rock. The barite occurs in narrow, irregular veins in the granite, particularly near the contact with the quartzite, and to a less extent, in the quartzite. There is said to be very little impurity in the Stackhouse barite. The mine openings are mostly well above the streams, and it would seem that there is a considerable reserve of the mineral in the deposit.

A deposit of barite 6 miles south of Hot Springs, Madison County, on Spring Creek, and known as the Noah Wardrop Barite Mine, was examined in the summer of 1917 by Mr. John E. Smith. The barite is approached through the tunnel about 300 feet long, entering on a level near the foot of the hill. The shaft enters from a point near the top of the hill and follows on the vein, which is on the angle of the dip about 55° northwest. The shaft is now about 150 feet deep and the barite occurs in lenses up to 6 feet in thickness, averaging about 2 feet thick. These lenses lie beneath a roofing of red to brown rotted material, forming an impure clay, and above a flooring of several "sandstones"—a decaying fine grained granite. Above the roof is a green stone, firm and compact, except where barite is being changed to limonite. This is a protection against the heavy weight above. The hoisting is done by steam power. The tunnel cuts the shaft about 40 feet above the present face of the barite, and this affords excellent ventilation in the mine. The barite is sorted by means of a fork, only the larger pieces being used at present. This is hauled to Hot Springs for shipment.

Production

For the past five years the production of barytes has been made by less than three producers, and therefore the statistics are given under "Miscellaneous Minerals," in the total production of the State. The figures used for the barytes are the value of the crude and not of the refined barytes, which is the condition in which most of it is shipped.

Owners of Barytes Properties and Operators During 1917

Charles L. Lawson, Bessemer City, Gaston County, N. C.
J. T. & J. B. Harrison, Bluff, Madison County, N. C.
Thomas Frisbee, Bluff, Madison County, N. C.
Anson G. Betts & Co., Sandy Bottom (Stackhouse) Madison County, N. C.
Carolina Barytes Co., Stackhouse, Madison County, N. C.
Ben W. Gahagan, Stackhouse, Madison County, N. C.
Amos Stackhouse & Sons, Stackhouse, Madison County, N. C.
Thompson, Weinman & Co., Stackhouse, Madison County, N. C.

MONAZITE

"*The mineral monazite contains a variable but small percentage of thoria, which is extracted and sold in the trade as thorium nitrate. Upon ignition this nitrate is changed to the oxide or thoria, which glows intensely when heated and is used in the manufacture of incandescent mantles for gas lights. Monazite occurs throughout the world but forms only a very small fraction of 1 per cent of the rock containing it. On decomposition of this rock the monazite and other resistant minerals are not attacked chemically but remain unaltered and, being much heavier than the products of decomposition, are gradually but slowly concentrated in the residue from the broken down rock. If the ocean encroaches on an area of such decomposed rock, the selective action of the sea waves will still further concentrate the heavier minerals along the beaches. River waters will likewise effect a concentration of the heavy minerals.

"In both North Carolina and South Carolina such river deposits were first worked about 1887 and soon yielded large quantities of monazite sand, the production in 1895 exceeding 1,500,000 pounds. At this time monazite from the rich coastal deposits of Brazil entered the market, and the domestic production fell to almost nothing, that for the two years 1896 and 1897 being worth only $3,480. The price of thorium nitrate, which was about $200 a pound in 1895, when the production in the Carolinas reached its maximum, was rapidly lowered to about $7 a pound in Europe in 1900. During the next few years it rose to about $11 a pound, and the increase in price, together with a world-wide search for additional deposits of monazite sand, served to revive the industry, until in 1905 over 1,000,000 pounds of monazite sand was again produced in the Carolinas. Much of this output was exported to Germany. In 1906 and again in 1910 the price of thorium nitrate was considerably reduced, and in 1913 it was selling in this country at $2.60 a pound. At this low price it became unprofitable to mine monazite sand wherever the cost of mining was high. After 1905 the domestic production gradually decreased, and since 1911 it has been inappreciable.

"In 1909 monazite sand was discovered in Travancore, India, and soon large amounts were produced. The Carolina sand has had to compete with these deposits and others in Brazil, which could be mined very cheaply. Most of the Brazilian sand and all of the India sand was exported to Germany until the beginning of the European war.

*"Mica, Monazite, and Lithium Minerals," by Waldemar T. Schaller, Bulletin 666-X, U. S. Geological Survey.

Since then most of the sand has been sent to this country, which imported nearly 2,500,000 pounds of monazite sand in 1916. With this increase in imports of monazite sand there has been a steady decline in imports of thorium nitrate, from 119,044 pounds in 1913 to 909 pounds in 1916. In other words, the United States is manufacturing its own thorium nitrate, chiefly from sand imported from Brazil and India. The price of thorium nitrate has gradually increased since the war and now is about $8 a pound, or three times as much as in 1913. This advance in price has again stimulated the domestic production of monazite sand, and small amounts were produced in 1915 and 1916.

"There is still an abundance of monazite sand in the Carolinas, but the Carolina deposits can not be worked extensively in competition with foreign sand. As the United States consumes about one-fourth of the thorium nitrate used in the world, it requires a yearly production of about 2,000,000 pounds of monazite sand (90 per cent monazite containing 5 per cent thoria). Even in its most prosperous times the domestic output did not reach that figure. Whether such a domestic production could be sustained year by year if all imports were cut off cannot be told. The Carolinas, however, could produce enough monazite sand to make this country independent of other sources for several years at least, and if the ashes of broken mantles were conserved by consumers, enough thorium nitrate could be obtained from domestic sources to serve for some time.

"The factors that have prevented a thorough test of the extent of the domestic deposits in recent years are the better quality and cheapness of the imported foreign sands. Both the Brazilian sand and that of India contain a higher natural concentration of monazite and a higher content of thorium oxide than the American sand, the sand from Brazil averaging about 6 per cent thoria and that from India about 9 per cent. The cheapness of labor and transportation in these foreign countries has also deterred domestic exploitation. The market price of thorium nitrate is a good indicator for domestic production of monazite sand, for only at a high price for this manufactured salt can the domestic sands be profitably worked. The importation of large quantities of foreign sand rich in thoria prevents a very high price being paid for thorium nitrate."

Production

There was no production of monazite in North Carolina during 1913 and 1914, but there was a production during 1915, 1916 and 1917, this being obtained principally from Burke, Cleveland, Iredell, Lincoln, and Rutherford counties. There were only two producers in 1915 and two

in 1916. In 1917, however, there were four producers who reported 77,743 pounds valued at $13,806.

In the table below there is given the production and value of monazite mined in North Carolina from 1893 to 1917, inclusive:

PRODUCTION OF MONAZITE IN NORTH CAROLINA, 1893—1917.

Year	Pounds	Value
1893	130,000	$ 7,600
1894	546,855	36,193
1895	1,573,000	137,150
1896	30,000	1,500
1897	44,000	1,980
1898	250,776	13,542
1899	350,000	20,000
1900	908,000	48,805
1901	748,736	59,262
1902	802,000	64,160
1903	773,000	58,694
1904	685,999	79,438
1905	894,368	107,324
1906	697,275	125,510
1907	456,863	54,824
1908	310,196	37,224
1909	391,068	46,928
1910	83,454	10,104
1911		
1912		
1913		
1914		
1915		*
1916		*
1917	77,743	3,806

*Only 2 producers. Included under "Miscellaneous Minerals," table, page 10.

Owners of Monazite Properties in North Carolina and Producers During 1917

Those marked with a star were producers in 1917.

John Alwan*.....Cleveland Mills, R. 1, Cleveland County, N. C.
E. C. Bess.....Cherryville, Gaston County, N. C.
Block Gas Mantle Co.....Youngstown, Ohio. Properties in Alexander, Burke, and Cleveland counties, N. C.
J. M. Brittain.....Connelly Springs, R. 1, Burke County, N. C.
Carolinas Monazite Co., care
L. A. Gettys.....Shelby, Cleveland County, N. C.
A. F. Cook.....Connelly Springs, Burke County, N. C.
W. A. Cook.....Belmont, R. 1, Cleveland County, N. C.
William Earl Hidden.....Ocean Grove, N. J., Tuxedo, Henderson County, N. C.
John R. Hoyle.....Shelby, Cleveland County, N. C.
D. F. Huffman*.....Connelly Springs, Burke County, N. C.

Jacob Johnson.....Cherryville, R.F.D.
Mines in Burke County, N. C.
W. E. Ledford.....Cleveland Mills, R. F. D. 4, Cleveland County, N. C.
Wade McClurd.....Cleveland Mills, R. F. D. 1, Cleveland County, N. C.
J. A. Martin.....Ellenboro, Rutherford County, N. C.
M. L. Hannicke.....Bostic, R. 3, Rutherford County, N. C.
New Process Gas Mantle Co...27 and 29 Bank Street, Philadelphia, Pa.
P. L. Newton.....Casar, Cleveland County, N. C.
D. F. Parker.....Cherryville, R. 1, Lincoln County, N. C.
S. S. Royster Monazite Co.*..Shelby, N. C.
Cleveland and Rutherford counties
A. A. Sain.....Henry, R. 3, Lincoln County, N. C.
James Smart.....Ellenboro, Rutherford County, N. C.
James C. Thorpe.....Harmony, Iredell County, N. C.
H. H. Van Horn*.....Connelly Springs, Burke County, N. C.
O. G. Wilson.....Ellenboro, Rutherford County, N. C.
J. A. Newton.....Casar, Cleveland County, N. C.

ZIRCON

So far as reported, there has been no production of zircon during the past five years.

In the table below there is given the amount and value of zircon mined in North Carolina from 1902 to 1917, inclusive:

PRODUCTION OF ZIRCON IN NORTH CAROLINA, 1902—1917, INCLUSIVE.

Year	Pounds	Value
1902	2,000	$ 380
1903	3,000	570
1904	1,000	200
1905	8,000	1,600
1906	1,100	248
1907	204	46
1908	----------	----------
1909	2,000	250
1910	----------	----------
1911	3,208	802
1912	----------	----------
1913	----------	----------
1914	----------	----------
1915	----------	----------
1916	----------	----------
1917	----------	----------

TALC AND PYROPHYLLITE

North Carolina ranks first among the states in the production of high grade talc, such as is used for pencils, gas tubes, and electrical insulators. There are two minerals which are being mined in North

Carolina and put on the market as talc; one being the pure talc which is a hydrous magnesium silicate, and the other the mineral pyrophyllite, which is a hydrous aluminum silicate. They are very similar in physical properties, but the pure talc is of greater value. The talc deposits are all in the western part of the State, principally in Cherokee, Swain, Graham and Jackson counties; while pyrophyllite is obtained from Moore County and the east central portion of the State.

A deposit in Cherokee County was examined by Mr. John E. Smith in the summer of 1917. The mine is operated by Mauney and Tait of Regal, N. C., and is located a quarter of a mile northeast of Regal, on the east side of the track. This is the old Emerson and Lidle mine and was in operation 16 or 17 years ago. A new shaft was sunk about 30 yards north of the old one. At the time of the examination the shaft was 55 feet deep, 5 feet square in the clear, and walled with hewn timber. The talc "vein" is 9 to 10 feet wide and commercial talc was first found about 15 feet below the surface. It is hoisted from the mine in a 200-pound bucket bound with heavy iron bands, and brought to the surface by means of mule, rope and pulley. The product is yellow talc used for foundry facings and as an oil filler, and sells for $4 per ton, f. o. b. Regal. The talc occurs near the contact between quartzite on the east and vertical mica schist on the northwest, the strike being N. 45° E.

Production

As there is very little talc sold in the crude state, the values given are for the production as it was marketed, and it usually represents the manufactured product.

There is given in the table below the condition in which these products were marketed for the past five years.

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA DURING 1913—1917, INCLUSIVE.

	1913		1914		1915		1916		1917	
	Quantity, Short Tons	Value	Quantity, Short Tons	Value	Quantity, Short Tons	Value	Quantity, Short Tons	Value	Quantity, Short Tons	Value
Ground Talc for powders, etc.	4,122	$33,103	845	$ 8,893	1,351	$10,610	1,408	$ 8,953	1,576	$ 15,050
Talc cut into pencils, gas tips, etc.	52	14,393	49	18,499	20	4,750	39	15,750	70	4,000
Talc sold, crude	412	921	300	600	69	2,180	311	9,857	54	216
Soapstone cut into slabs for chimneys, etc.	90	400	4	421	14	3,961	29	7,264	475	22,500
Totals	4,676	48,817	1,198	28,413	1,454	21,501	1,787	41,824	2,175	41,766

The table below shows the quantity and value of talc and pyrophyllite in North Carolina from 1898 to 1917, inclusive:

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA, 1898—1917, INCLUSIVE.

Year	Quantity	Value
	Short Tons.	
1898	1,695	$ 27,320
1899	1,817	31,880
1900	4,522	75,308
1901	5,819	77,974
1902	5,239	88,962
1903	5,331	76,984
1904	3,801	65,483
1905	4,035	74,940
1906	4,184	66,979
1907	4,085	74,347
1908	3,564	51,443
1909	5,956	77,983
1910	3,887	69,805
1911	3,548	57,101
1912	3,542	63,304
1913	4,676	48,817
1914	1,198	28,413
1915	1,454	21,501
1916	1,787	41,824
1917	2,175	41,766

Producers of Talc and Pyrophyllite During 1917

Alleghany—G. F. Smith, Peden, N. C.
Ashe—Gregory Talc Co., Nashville, Tenn.
Cherokee—Kirkpatrick Development Co., Asheville, N. C.
Madison—Georgia Talc Co., Asheville, N. C.
Moore—Talc Products Co., 11 Pine St., New York.
Swain—N. C. Talc & Mining Co., Hewitts, N. C.

PRECIOUS STONES

There are many of the gem minerals found in North Carolina, and deposits of some have been found in sufficient quantity to become regular producers. There has been but little systematic search for these minerals, but accidental discoveries have been made in various places that have in some cases led to the opening of good deposits of gem material. The principal gem localities are in Macon, Yancey, Mitchell, Lincoln, Alexander, and Cleveland counties. These gems have been described in some detail in Economic Papers Nos. 6, 9, 15, 23 and 34.

The principal gems that have been produced in the past five years in North Carolina have been the amethyst, beryl, quartz, ruby, sap-

phire, emerald, kyanite, and rhodolite. Some of the gems discovered within this period are described as follows:

Amethyst: A few amethystine quartz crystals and one amethyst of good quality was found in 1913 on the R. C. McConnell place, about 3 miles southwest of Mt. Ulla, in Iredell County. The good specimen was found some 20 years ago by the late N. H. Marsh. This was a partly water-worn crystal about 2 inches long and 1¾ inches thick. A large part of it was flawless, with pleasing medium dark purple color. The value of this crystal was not large, but the possibility of a deposit being found is important.

Ruby: Tests were made on the ruby deposits along Caler Fork of Cowee Creek in Macon County during the latter part of 1913. Prospecting was under the charge of N. E. Isbell of Cincinnati, who had charge of the developments at this locality several years before. Mr. Isbell used a churn drill during this work, going to a depth of 65 feet at the "In Situ" Hill locality. Some ruby and sapphire of marketable color were found along with opaque corundum. During the first part of 1914 better equipment in the way of a 3-inch core drill, operated by a 10-horsepower gasoline engine, was installed, and a number of holes will be sunk at the "In Situ" Hill locality to the depth of about 150 feet.

In his report on Gems and Precious Stones for 1914, Mr. Douglas B. Sterrett says:

"Prospecting at the ruby deposits on Caler Fork of Cowee Creek, in Macon County, N. C., during part of 1914 did not result in a definite determination as to whether or not the property can be profitably worked. Earlier work for rubies a number of years ago in the gravel beds in the bottom land along the creek resulted in the discovery of much red and pink translucent corundum and of some clear stones of value as gems. The best stones had a fine ruby color with silkiness and slight cloudiness in some specimens. Prospecting of the gravel beds carried the work back to a point where the valley narrows below a flat. Here ruby corundum was found in matrix and the hillside was called In Situ Hill. At several different times prospecting has been carried on in this hillside in search of the remaining part of the deposit from which the best rubies of the placer ground have been obtained.

"Prospecting work at the In Situ Hill locality was begun in 1913 by the Consolidated Ruby Co., of New York, and was continued in 1914. The new work consisted of a shaft 38 feet deep from the bottom of the open cut at the foot of the hill. From this shaft drifts were run 58 feet west and 80 feet south of east. Several holes were sunk by a churn drill, using chilled steel shot for cutting edges. One of these holes was 103 feet deep, cutting through all the saprolite or decomposed rock into fresh, unaltered gneiss. The fresh rock from the drill core consists both of garnetiferous diorite and garnetiferous biotite gneiss. The garnetiferous diorite would probably yield yellowish brown saprolite just like that found in the upper workings of In

Situ Hill. No pockets containing ruby corundum were found in the drill holes. In the shaft and the underground workings a vein, or seam, was followed, in which several small and one large pocket, or deposit, carrying ruby corundum were found. The largest deposit was a shoot, or chimney, measuring 6½ feet high by 3½ feet wide, and was nearly 4 feet thick. The material taken from this deposit, when washed, yielded about 20 pounds of translucent pink corundum. These crystals range from small size up to a centimeter in diameter and thickness. None of them has fine red color, and most of them are pink to purplish red. Nearly all of the crystals contained small rust cavities up to 2 millimeters in diameter, formed by the decomposition of minute rhodolite garnets similar to those described by Pratt and Lewis.[1]

The corundum crystals are inclosed in whitish kaolin-like deposits, apparently resulting from the decomposition of feldspar or pegmatitic material which originally inclosed the corundum. None of these rubies is of as deep a color or is as clear as those found in the stream gravels below In Situ Hill, but the richness of the pockets adds to the interest of prospecting for stones of better quality."

Beryl: A beautiful beryl, weighing 3 pounds and containing good gem material, was reported by Mr. L. A. Gettys of Shelby, North Carolina, to have been found in Burke County in 1915.

Quartz: Transparent quartz crystals that include goethite needles were mined near Bakersville, North Carolina, by W. G. Bowman in 1915. The hair-like needles of geothite give a rainbow hue to the specimens.

On land of N. C. Pannell, 3½ miles north of Ellenboro, dikes of pegmatite carrying yellow beryl, aquamarine, tourmaline, and irridescent albite feldspar have been located. Mr. Pannell's address is Ellenboro, Route 2.

---

[1]Pratt, J. H., and Lewis, V. L., Corundum and the peridotites of western North Carolina: North Carolina Geol. Survey, vol. 1, p. 183, 1905.

Production

There is given in the table below the production of precious stones in North Carolina for the years 1900 to 1917, inclusive:

PRODUCTION OF PRECIOUS STONES IN NORTH CAROLINA, 1900—1917, INCLUSIVE

Year	Value
1900	$ 12,020
1901	24,245
1902	5,300
1903	1,525
1904	10,600
1905	3,350
1906	5,000
1907	7,580
1908	*570
1909	*479
1910	*700
1911	*10,735
1912	*5,655
1913	*849
1914	*3,070
1915	*464
1916	*343
1917	*75

*Estimated by U. S. G. S.

MINERAL WATERS

There is included under the head of "mineral waters" any spring or well water that is sold in bulk or packages for table or medicinal use. Water sold as public supplies is excluded from these statistics, as are also natural waters which have been greatly changed either by the addition of mineral substances or by concentration by evaporation. The figures given below regarding the value of mineral waters are those furnished by the spring owners and represent as nearly as possible the amount received for the water exclusive of prices charged for the containers.

The springs which were in operation during the years covered by this report are as follows:

1913

"The returns from North Carolina show marked increase in the mineral water business during 1913. The sales amounted to 176,068 gallons, valued at $23,877, as compared with 144,708 gallons, valued at $22,385, in 1912, an increase of 22 per cent in quantity and of 7 per cent in value. The average price per gallon decreased from 16 to 14 cents. Parks Spring reported production for the first time. One spring

active in 1912 was idle during 1913, and the output from one spring from which no report was received was estimated on the basis of the production for 1912, these changes increasing the number of commercial springs to 17. Eleven resorts accommodating 1,600 guests were maintained at springs, together with five establishments for bathing in mineral water. A small quantity of water also was used in the manufacture of soft drinks.

"The 16 springs reporting are:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Springs, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Spring, Shelby, Cleveland County.
Smith Lithia Spring, Oxford, Granville County.

1914

"The sales of mineral water in North Carolina in 1914 amounted to 158,226 gallons, valued at $21,964, as compared with 176,068 gallons, valued at $23,877, in 1913, a decrease of 10 per cent in quantity and of 8 per cent in value. The average price per gallon remained 14 cents, as in 1913. Ten resorts, accommodating 1,650 guests, and 3 establishments for bathing in mineral water were maintained at springs. A small quantity of water also was used in the manufacture of soft drinks.

"The same springs, 17 in number, were active during 1913, and the names and locations of them follow:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.

Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Springs, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Spring, Shelby, Cleveland County.
Smith Lithia Spring, Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

1915

"The mineral water business in North Carolina decreased 16 per cent in quantity and 15 per cent in value during 1915, and the average price remained the same—14 cents. The total sales amounted to 132,813 gallons, valued at $18,745, as compared with 158,226 gallons, valued at $21,964, in 1914. A small quantity of mineral water also was consumed in the manufacture of soft drinks. Twelve resorts, accommodating 1,900 guests, and two establishments for bathing in mineral water were maintained at springs. Production was reported for the first time from Bromine Arsenic Lithia Springs. One spring active in 1914 concerning which no report was received in 1915 was considered idle.

"The 17 springs that reported production are as follows:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, Shelby, Cleveland County.
Vade Mecum Spring, Vade Mecum, Stokes County."

1916

"The mineral water business in North Carolina remained practically the same in 1916 as in 1915, and the average price per gallon remained the same—14 cents. The sales amounted to 137,817 gallons, valued at $19,010, as compared with 132,813 gallons, valued at $18,745, in 1915. No mineral water was consumed in the manufacture of soft drinks.

Twelve resorts, accommodating about 1,700 guests, and three establishments for bathing in mineral water were maintained at springs. Derita Mineral Spring is now known as Derita Calcic Spring.

"The 19 springs that reported production are as follows:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Mineral Spring, Connelly Springs, Burke County.
Derita Calcic Spring, Derita, Mecklenburg County.
Haywood White Sulphur Springs, Waynesville, Haywood County.
Huckleberry Springs, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Mildas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, near Shelby, Cleveland County.
Sherrill Mineral Springs, near Cabarrus, Cabarrus County.
Smith Lithia Springs, near Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County."

1917

There was a decrease in the mineral water business in North Carolina in 1917 as compared to 1916, though there was a slight increase in the average price per gallon, which was 15 cents in 1917 and 14 cents in 1916.

There were 18 active springs during 1917, one being a new spring, the Rivermont Carbonated Spring of Durham County. The following are the springs which reported a production in 1917:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Springs, Bullock, Granville County.
Connelly Mineral Spring, Connelly Springs, Burke County.
Derita Calcic Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Springs, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Springs, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Rivermont Carbonated Spring, near Durham, Durham County.

Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, near Shelby, Cleveland County.
Smith Lithia Springs, near Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

Production

The table below gives the quantity and value of mineral waters which were put on the market for 1901-1917, inclusive:

PRODUCTION OF MINERAL WATERS IN NORTH CAROLINA
1901—1917, INCLUSIVE.

Year	Amount, Gallons	Value
1901	375,700	$ 42,167
1902	104,400	18,795
1903	83,100	13,085
1904	145,800	21,902
1905	201,000	38,755
1906	158,680	31,413
1907	193,479	40,302
1908	171,395	27,163
1909	128,171	20,558
1910	143,007	21,389
1911	231,510	31,108
1912	144,708	22,385
1913	176,068	23,877
1914	158,226	21,964
1915	132,813	18,745
1916	137,817	19,010
1917	103,659	15,664

Producers of Mineral Waters During 1917

All Healing Springs, care
O. F. Pool.....Taylorsville, Alexander Co., N. C.
Vitalizer Mineral Springs
Co., care John B. Ross...Charlotte, N. C., Springs at Barium Springs, Iredell County.
Bromine-Arsenic Lithia
Springs .....Abingdon, Va., Springs in Ashe County, North Carolina.
Buckhorn Lithia Water Co..Bullock, Granville County, N. C.
A. H. Alexander.....Derita, R. F. D. 14, Mecklenburg County, N. C.
Mrs. J. L. Morgan, Haywood
White Sulphur Springs...Waynesville, Haywood County, N. C.
J. J. Riley.....302 Milton Ave., Durham, Durham County, N. C.
J. L. and Frank Page.....Jackson Springs, Moore County, N. C.
Midas Spring Water Co....218 E. Fifth St., Charlotte, Mecklenburg County, N. C.
Moores Spring Mineral Co..Moores Springs, Stokes County, N. C.

Mt. Vernon Mineral Water Co. ..... Mt. Vernon Springs, Chatham County, N. C.
Panacea Springs Co..... Littleton, R. F. D. 1, Warren County, N. C.
Parks Spring Water Co..... Danville, Va., R. F. D. 5, Springs in Caswell County, N. C.
Dr. R. L. Holloway..... West Durham, Durham County, N. C.
Raymond Maxwell ..... Sevensprings, Wayne County, N. C.
Shelby Lithia Water Co., care H. B. Quinn..... Shelby, Cleveland County, N. C.
Smith Lithia Water Co..... Oxford, Granville County, N. C.
J. Cicero Tise ..... Winston-Salem, N. C., Springs at Vade Mecum, Stokes County, N. C.

FELDSPAR

"The feldspars are among the most widely distributed minerals and occur as constituents of nearly all igneous rocks. In most rocks, however, feldspar is in too small grains and is too intimately associated with other minerals to be of commercial importance. Commercially valuable feldspar usually occurs as a constituent of pegmatite—rocks of extremely coarse grain and irregular texture. In mineral composition, pegmatites vary greatly, but those of present commercial importance belong generally to two types: (1) the granite pegmatites or "giant granites," composed essentially of feldspar, quartz, and mica; and (2) the soda pegmatites which consist mainly of soda feldspar (albite) and small quantities of hornblende. By far the larger number of the feldspar quarries of the United States are in deposits of granite pegmatite. These granite pegmatites contain, besides feldspar, the following minerals in abundant proportions: quartz, muscovite (white mica), biotite (black mica), and black tourmaline. Generally less abundant are garnet, magnetite and beryl.

"The potash and potash-soda feldspars mined in the United States are mostly pale flesh color to nearly white. Some are reddish and pearly gray. Soda feldspars and soda-lime feldspars are commonly pure white or light gray and pale green in color. When finely ground, all commercial feldspars are either white or very pale pink.

"Feldspar is used principally in the manufacture of pottery, chinaware, porcelain, enamel ware, and enamel brick and tile. It is used in both the body and the glaze on ceramic products. As an abrasive, it is usually a constituent of scouring soaps and window wash. Other uses of feldspar which do not require high grade material are in the manufacture of emery and corundum wheels, where it serves as a binder; in the manufacture of glass; as a poultry grit; as a constituent of roofing material; and for surfacing concrete work. Small quantities

of the purest grades of potash feldspar are used in the manufacture of artificial teeth. For this latter purpose it brings the highest prices—$6 to $8 a barrel of 350 pounds.

"The use of ground feldspar as a fertilizer has been proposed and many tests have been made by the United States Department of Agriculture. This is of particular interest at this time in view of the great need for potash for agricultural purposes. It may be stated here that one company in North Carolina has recently reported that they have perfected a process for the extraction of potash from the feldspar.

"The requirements of the pottery trade demand that in general the percentage of free quartz associated with the feldspar used for this purpose shall not exceed 20 per cent in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent of free quartz. A factor of the utmost importance in the mining of pottery spar is the quantity of iron-bearing minerals (black mica, hornblende, black tourmaline, etc.) present and the manner in which these minerals are associated with the feldspar. The requirements of the pottery trade demand that the spar be nearly free from these minerals.

"Feldspar is a common mineral in North Carolina as a constituent of all granites and gneisses and of pegmatitic dikes. A great deal of it, however, found near the surface, especially in the southern counties, has been either partially or wholly kaolinized so that it is not of value as a feldspar for pottery manufacture; but in many cases, has formed extensive beds of kaolin. In the northern counties, however, fresh, unaltered feldspar occurs in quantity. These are found for the most part as constituents of pegmatitic dikes that are being worked for mica, and most of the mines now producing feldspar or kaolin were formerly opened as mica mines. In fact, in a great many of the feldspar mines mica and kaolin are obtained as by-products. The principal feldspar mines now being worked are in Avery, Mitchell and Yancey Counties, principally in the vicinity of Spruce Pine, Plumtree and Penland, Mitchell County; and Dobag, Micaville and Burnsville, Yancey County. There are regions of Iredell, Lincoln and Cleveland and of Jackson, Macon and Swain counties where there are particularly promising prospects."

The following notes in regard to North Carolina Feldspars taken from Bulletin 92 of the United States Bureau of Mines on "The Feldspars of the New England and north Appalachian States," by A. S. Watts, published in 1916:

"The feldspar deposits of North Carolina are distributed throughout the mountain section southeast of the Great Smoky Mountains. The most prom-

ising districts are those described in Bulletin 53 of the Bureau of Mines[1] as the Cowee district and the Sprucepine district. The former includes parts of Jackson, Macon, and Swain counties and the latter includes parts of Yancey, Mitchell, and Avery counties. The feldspars throughout this State are, as a rule, cream white microclines with very low soda content. A few small deposits of soda feldspar and anorthoclase were noted but the great majority of deposits in North Carolina are of potash feldspar, most of it being extremely coarse pegmatite, and, as the field is new, a large amount of pure feldspar is to be found as lenses in the pegmatite. Many of the pegmatites are so coarsely crystalline that the quartz content can be almost entirely removed by cobbing. The dikes are seldom large, however, and as most of them stand almost vertical, the problem of mining is more difficult than where the deposits are large lenses or lie nearly flat, as is the case with many deposits farther north. The chief impurities are quartz and muscovite, with smaller amounts of biotite, beryl, and garnets. The latter three minerals, however, are seldom present in quantity sufficient to affect injuriously the color of the product, and the muscovite is generally coarsely crystalline and not generally distributed throughout the entire mass. The mining in the Cowee district is confined to mining for mica and no attempt is made to remove the feldspar except where it interferes with the mining of the mica. In the Sprucepine district, three feldspar quarries are now in operation and others are to be opened in the near future. The potash feldspars of North Carolina may be safely represented by the following analyses:

Analyses of Potash Feldspars of North Carolina.

(D. J. Demorest, Analyst.)

Constituent	A	B	C	D	E
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Ignition loss	0.90	0.17	0.60	0.30	0.40
SiO_2	64.48	65.37	63.90	65.68	64.93
Al_2O_3	19.43	17.92	19.97	19.08	19.45
Fe_2O_3	.01	.02	.15	.14	----
CaO	----	.17	.05	----	.05
MgO	----	----	----	----	----
BaO	----	----	.70	----	----
K_2O	13.19	13.05	13.20	13.09	12.46
Na_2O	1.84	2.10	1.01	2.08	2.54
Totals	99.85	98.80	99.58	100.37	99.83

The following article on "Feldspar and Kaolin in the Clinchfield Territory"*, by W. H. Kemler, Industrial Engineer of the Carolina, Clinchfield & Ohio Railway, will be of interest:

[1]Watts, A. S., Mining and treatment of feldspar and kaolin in the Southern Appalachian region: Bull. 53, Bureau of Mines, 1913, p. 12.

**Manufacturer's Record*, July 31, 1913, volume 64, page 51.

Feldspar and Kaolin in the Clinchfield's Territory

"The present greatest general interest in connection with exploratory work and mineral development projected and under way in the territory of the Carolina, Clinchfield & Ohio Railway probably is evidenced just now by the activity in the feldspar and kaolin belt, on the west slope of the Blue Ridge and east slope of the Black Mountains, in Mitchell and Yancey Counties, North Carolina.

"Unceasing energy is being displayed in exploring virgin ground, and a number of large and important factors in the feldspar-producing business are preparing to develop these extensive deposits of highgrade potash feldspar, the value to the ceramic and kindred industries having been established during the past 12 months by the consumption of nearly 7,000 tons of this feldspar in Northern and Eastern markets in competition with the feldspar mined in Maine, Connecticut, New York, Pennsylvania, Maryland, and Canada.

"The topographic location of these deposits, their proximity to the railway, ease in mining and ready access to the markets of the Eastern and North Central States, warrant the belief that this valuable mineral resource is destined to create a new center for a large mining development, and particularly so in the event of a successful commercial method of potash extraction from feldspar being evolved.

"Recent progress in this direction indicates that several well known patented processes can be developed under conditions that assure success and which would labor under adverse conditions in other less favored spar districts.

"The occurrence in this territory of secondary minerals essential to the operation of these processes, such as barytes, gypsum, fluorspar, salt, limestone, etc., combined with ready sources of the various acids, by-products, cheap fuel, hydro-electric power and other facilities for chemical manufacture, makes the successful development of this much-sought fertilizer agent one of great commercial importance.

"Such a potash production would stimulate other lines of chemical development, and the manufacture of many other valuable combinations of potassium salts and compounds would follow in the South.

"A ready market for potash salts is evidenced by the enormous consumption of the imported salts by the fertilizer and other industries of the Southern States, and it only remains for capital to investigate the potentiality of these large resources, their ease of development and the profitable returns that can be realized from their development.

"Extensive experimental work to the point of semi-commercial plant installations is now being conducted in the East by men identified with the chemical progress of this country, and while many heretofore have sought but the extraction of the potash alone, which would not pay, the prominent research investigators hereafter mentioned have not lost sight of the valuable by-products produced in their processes and the putting of these by-products into marketable form, and upon these features the future commercial success of potash extraction from feldspar is dependent. The several processes

patented by Professor Hart, of Lafayette College; Professor Morse, of the University of California, and Professor Doremus, of New York City, and which undoubtedly represent the best practical methods evolved, can all be worked under exceptionally flattering economic conditions, and it is manifest to those conversant with such chemical research work that any future development along these lines will be concentrated south of the Ohio River and in the immediate territory adjacent to the basic minerals required, as well as cheap power and labor.

"Kaolin, or china clay, has been produced for almost a decade along that portion of the Clinchfield route formerly known as the South and Western Railway, the mines and washing plants being located at Spruce Pine and Penland, N. C., these developments being confined to one company, and the superiority of this type of china clay is now well established. However, increased expansion of the ceramic industry throughout the United States, the decrease in imported kaolins and the exhaustion of similar clay deposits in other districts justifies further development of this excellent raw product, as it stands second to none thus far mined in this country.

"Many deposits advantageously located occur tributary to the railway in its Mitchell and Yancey County (North Carolina) mileage.

"These clays are residual, that is, formed at the point they originated through the decay of pure veins of feldspar, pegmatite or granite, and their initial purity varies according to the contaminations which occur in the vein from which they were formed.

"The commercial extent of any deposit can be easily determined by sinking test pits and by drilling. Those now being worked are vein formations of considerable length, whose depth is comparatively great as relative to their width. The accessibility of these deposits does not depend entirely upon distance from the railway, as the crude clay can be transported in almost every case to a washing plant by sluicing with water, the supply of which is normally fulfilled by the mountain streams, and can be carried long distances, as fairly steep and uniform grades between the deposits and water is available, and the deposits being, as a rule, located at considerable heights above the railway, no difficulty in handling the clay by this system would be encountered with.

"Renewed interest is being directed to these valuable deposits, and it is reasonably expected that the development along these lines will increase as the commercialization of these clays becomes more common and modern engineering methods replace the obsolete means of preparing the clays that now prevail. This wonderful resource is well deserving of increased exploitation, and the success of the plants now in operation might be excelled through development in accordance with modern ideas.

"The evolution of a cheap and satisfactory method of extracting alumina from kaolin would mean increased stimulation in the production of these clays, and it is becoming cognizant to those identified with industrial research that the solution of this problem is not far distant and will be one of practicability.

"To the progressive factor, seeking an outlay for capital, no better field for investment can be located, and the future of this industry is exceptionally bright in view of the fact that the ceramic industry is gradually pointing South, the foundation for both raw materials and future markets."

Production

North Carolina first began producing feldspar in 1911, at which time the Carolina Mineral Company of Penland, Mitchell County, was the only producer. At that time North Carolina had sixth place in the production of the United States. In 1913 it was again sixth in the production by States, the output being almost entirely from two companies in the Spruce Pine district, Mitchell County. In 1914 North Carolina had sixth place in value and fifth place in quantity. The output was reported by four operators in the Spruce Pine district of Mitchell County, and amounted to 15,420 tons, valued at $43,153. In 1915 North Carolina was third in the order of production, with an output of 20,635 long tons, valued at $55,991. In 1916 there was produced in North Carolina 30,955 long tons, valued at $77,446, North Carolina being second among the states in the order of its production. In 1917 North Carolina ranked first in the quantity and second in value among the states of the country in its production of feldspar. Reports of production were received from 24 quarry operations, chiefly in the Spruce Pine district in Mitchell, Avery and Yancey counties. The total output was 42,463 tons, valued at $131,442. Prices ranged from $2.60 to $7.00 a ton, averaging $3.10. Much of the output was ground at Erwin, Tennessee, and the remainder went chiefly to mills at East Liverpool, Ohio, and Trenton, New Jersey.

Feldspar Mills

It may be of interest to have the names and addresses of mills operated by feldspar consumers for grinding spar for their own use. The following are mills in the eastern states operated by dealers in feldspar at the places named:

Maine Feldspar Co., Auburn and Topsham, Maine; Trenton Flint and Spar Co., Cathance, Maine; Louis W. Howe, South Glastonbury, Conn.; Bedford Mining Co., Bedford, N. Y.; Pennsylvania Feldspar Co., Barnard, N. Y., and Toughkenamon, Pa.; Brandywine Summit Kaolin & Feldspar Co., Brandywine Summit, Pa.; Eureka Flint & Spar Co., Trenton, N. J.; Golding Sons Co., Trenton, N. J., Wilmington, Del., and East Liverpool, Ohio; Potters Mining & Milling Co., East Liverpool, Ohio; Newell Mining & Pulverizing Co., Newell, W. Va.; Clinchfield Products Corporation, Erwin, Tenn.; and Rochester Feldspar Mills (Inc.), Rochester, N. Y.

Producers of Feldspar During 1917

Edward Blake.....Newdale, Yancey County, N. C.
Carolina Mineral Co.....Penland, Mitchell County, N. C.

Carolina Spar & Mica Co.....Forbes, Mitchell County, N. C.
Cedar Cliff Spar Co.....Tile Station, Zanesville, Ohio. Near Micaville, Yancey County, N. C.
Clinchfield Products Corporation.....100 Williams Street, New York, N. Y. Kona, Mitchell County, N. C.
Eureka Flint and Spar Co.....Trenton, N. J., and Penland, Mitchell County, N. C.
F. G. Ganett
Hall and McMahon
R. B. Harrison.....Spruce Pine, Mitchell County, N. C.
Hickey & Turbyfill
Geo. W. Owens.....Greenmountain, Yancey County, N. C.
Mrs. J. H. Phillips
S. L. Phillips
T. C. Robinson
U. S. Development Co.....Lunday, Mitchell County, N. C.
Carl Williams, Jr.....Toecane, R. 1, Mitchell County, N. C.
Carolina Products Co.....Bandana, Mitchell County, N. C.
Glass Brick Co.....Huntington, W. Va. Kona, Yancey County, N. C.
Wiseman Mines Corporation....Spruce Pine, Mitchell County, N. C.
Z. C. Harris.....Windom, Yancey County, N. C.
H. C. Smith.....Burnsville, Yancey County, N. C.
Toe River Mining Co.
Empire Mineral Co.....Estatoe, Mitchell County, N. C.
E. F. Watson

COAL

On the land of Mr. C. T. Garrett, about three miles from Hot Springs and three-fourths mile up Jack's Creek from the French Broad River, prospecting has been done for coal. This was first carried on about the year 1899 on the west side of Jack's Creek where a tunnel about 180 feet long was opened. About 1910 or 1911 two more tunnels were opened, one of them on a seam 40 feet below the upper one and five feet above the level of water in the creek. At another time a tunnel was dug eastward along the seam on the opposite side of the creek and a little farther up. In August, 1915, work was again begun on the upper seam and continued somewhat regularly until July, 1916. This tunnel was about 140 feet long and was drained with a siphon while the work was being done. In all, five tunnels have been dug.

So far as reported, there has been no production of coal in North Carolina since 1912. There have been reports, however, of revived interest in the Cumnock sections of Lee and Chatham counties, and in 1917 the Lee Coal Mining Company of Southern Pines was chartered for developing these properties. It is expected that opera-

tions will begin in 1918. A sample of coal from one of their openings was analyzed by the U. S. Bureau of Mines, with the following results:

Moisture (as received)	1.6
Volatile matter (dry coal)	33.9
Fixed Carbon (dry coal)	59.1
Ash (dry coal)	7.0
Sulphur (dry coal)	2.15
British Thermal Units (as received)	13,870
British Thermal Units (dry coal)	14,090

The old Egypt mine has been opened up, and it is expected that during 1918 this mine will become a producer.

There is given in the table below the production of coal in North Carolina since 1890:

Coal Production in North Carolina from 1890 to 1917.

Year	Quantity
	Long Ton
1890	10,262
1891	20,355
1892	6,679
1893	17,000
1894	16,900
1895	24,900
1896	7,813
1897	21,280
1898	11,495
1899	26,896
1900	17,734
1901	12,000
1902	23,000
1903	17,309
1904	7,000
1905	1,557
1906	----------
1907	----------
1908	----------
1909	----------
1910	----------
1911	----------
1912	120
1913	----------
1914	----------
1915	----------
1916	----------
1917	----------

GRAPHITE

Graphite is known to occur at many localities within the area of crystalline rocks in the central and western parts of North Carolina.

A number of years ago an unsuccessful attempt was made by the Southern Graphite Company to work a graphite deposit near Graphiteville, McDowell County.

In 1911, Charles Rennie of Franklin, N. C., reported the occurrence of clay graphite four miles west of Franklin. A few tons were shipped for treatment to the Federal Graphite Company at Warren, Ohio.

In 1912, a few tons of graphitic schist were mined at Barrett's Mountain in Alexander County, but none was refined or shipped.

There was no production of graphite reported from North Carolina for 1913, 1914 or 1915.

In 1916, there was a small output of amorphous graphite mined in Catawba County by the Aetna Graphite Company of Columbus, Ohio. H. M. Ashe & Company of Atlanta, Ga., prospected graphite deposits in Macon County.

There was no report of a production of graphite in the State during 1917. There was, however, a report of the discovery of a graphite mine on the plantation of Mr. W. A. Spangle, about 4 miles northwest of Shelby in Cleveland County, and it is reported that Mr. Spangle has leased this property to the General Graphite Company for a period of three years. This mine is expected to be a producer in 1918. It is also reported that a graphite plant is to be erected at Shelby for the purpose of utilizing the numerous pockets of graphite in Cleveland and adjoining counties.

RARE MINERALS

Associated with the pegmatites of Mitchell and Yancey counties are several rare minerals which have commercial value. Among these is the mineral pitchblende or uraninite. In Mitchell County small quantities occur near Penland in the quartz and feldspar mines. The mineral is usually associated with quartz, but in places with orthoclase feldspar, and still more frequently, with albite. Its presence is usually indicated by a dull green stain on the quartz or spar, although such stains do not invariably mean that ore is present. The pitchblende from near Penland is usually high grade and is found associated with yellow gummite. In probably the best mine only 50 pounds have been found in one and a half years; so that as yet the mining of these deposits cannot be considered a commercial enterprise. The ore is usually sold in small quantities, as museum specimens. No production of rare minerals has been reported for North Carolina during the period covered by this report, except a small production of samarskite in 1914.

GREENSAND

Because of the shortage in potash which the United States has recently experienced, there has been a special search made for new sources of supply in this country and for possible methods of utilizing

the mineral deposits containing potash. A report was made for the United States Geological Survey by Mr. George H. Ashley on "Notes on the Greensand Deposits of the Eastern States," supplemented by a report on "Methods of Analysis of Greensand" by William B. Hicks and Reginald K. Bailey. This is published as Bulletin 660-B of the United States Geological Survey.

While North Carolina has, so far as known, only a limited quantity of this material, yet because of the importance of discovering new sources of supply a brief sketch is given here with such data as has been assembled in regard to North Carolina deposits with the idea of creating such interest as may lead to the discovery of other deposits in this State. In his general introduction, Mr. Ashley says:

"Potash is exceedingly abundant in the earth's crust, but usually forms only a small percentage of the rock containing it. Most granites, for example,[1] contain 4 to 8 per cent of potash, and a few of the nephelite and leucite rocks contain over 9 per cent of potash. Many of the rhyolites, porphyries, trachytes, syenites, monzonites, and basalts contain more than 5 per cent of potash. Some minerals, such as sylvite (52.4 potassium) and niter (46.5 potash), contain more than 20 per cent, theoretically, of potash or of potassium, but these minerals are relatively rare in this country and have not yet been found in quantities large enough to be of commercial interest. A few other minerals, such as leucite, alunite, orthoclase, muscovite, biotite, and lepidolite, contain 4 to 16 per cent of potash, averaging about 8 per cent. These are the minerals for which special search has been made. At least one large deposit of leucite-bearing rock averaging about 10 per cent of potash is known in Wyoming, and a claim has been filed on it. Small but workable deposits of alunite, carrying 7 to 11 per cent of potash, have been found in Utah and adjoining States. Small deposits of sericite (muscovite) schist, carrying 5 to 8 per cent of potash, are known in Georgia and the Carolinas. The other minerals mentioned are abundant but are commonly scattered through the rocks as isolated crystals or occur as thin veins or stringers, so that though selected specimens may yield 10 per cent or more of potash, the quantity of such minerals in any body so far known that will maintain an average that high is relatively insignificant.

"In their extent and availability these resources of potash-bearing minerals or rocks present a strong contrast to the greensands of Eastern states, which underlie the surface of hundreds, if not thousands, of square miles within reach of the steam shovel, and which range in thickness from a few feet to 30 feet and carry 5 to 7 per cent of potash. As a cubic foot of greensand weighs about 90 pounds and (if 7 per cent material) contains 6.3 pounds of potash, a square mile of sand 1 foot thick will yield 78,000 tons of potash. A 20-foot bed that covers a square mile should yield 1,500,000 tons of potash; a 20-foot bed of 5 per cent greensand should yield 1,000,000 tons to the square mile and should also carry about 2,000,000 tons of iron, and possibly 500,000

[1]Clarke, F. W., The data of geochemistry, 3d ed.: U. S. Geol. Survey Bull. 616, pp. 433 et seq., 1916.

tons of phosphoric acid. The figures given apply to the best sands only, but if the samples taken indicate the character of the sand throughout the full thickness of the bed there are many square miles of greensand containing 7 per cent of potash and perhaps hundreds of square miles containing 4 or 5 per cent. In view of the possible ease of mining these sands they would seem to offer an adequate source of potash for perhaps several hundred years, provided a cheap method of extracting the potash can be found.

"The object of this paper is to place before chemical engineers and others succinct information as to the location and extent of easily accessible greensand deposits in the Eastern States and their content of potash, and thus to provide an answer for many inquiries made of the United States Geological Survey. The paper brings together the results of analyses of samples of greensand that were collected by W. C. Phalen and the writer, and analyzed in the chemical laboratory of the United States Geological Survey by W. B. Hicks and R. K. Bailey and gives notes on the occurrence and extent of the beds sampled. It will be noted that the analyses do not substantiate many older analyses of glauconite, the potash-bearing mineral in greensand, which gave 11 and 12 or even 14.5 per cent of potash. All modern analyses indicate that glauconite contains only 7 to 8 per cent of potash.

"The samples were taken from deposits that lie near transportation lines, either rail or water, and that could be handled cheaply, in large quantities, either by the steam shovel or dredge or other mechanical means. These limitations to the study were set in the belief that the demand for potash is urgent and possibly only temporary, and that what is immediately desired is rather information as to the best and most available deposits for possible utilization than a comprehensive report that would be of value in the development of the industry.

"After a brief review of the available information concerning the greensand deposits of the eastern United States, either published or unpublished, a number of the most promising deposits were selected for study. When the selection had been made Mr. Phalen visited areas in New Jersey, and the writer visited areas in Delaware, Maryland, Virginia, North Carolina, Tennessee, and Arkansas.

"In general, the results show that the best and most available deposits are in New Jersey and Delaware, samples from which yielded from 3.50 to 7.15 per cent of potash, the highest percentages coming from deposits in New Jersey. The samples from Maryland yielded 4.45 per cent or less; the samples from Virginia, which contained much lime, yielded 2 to 2.50 per cent; those from North Carolina 2.96 or less, and those from Arkansas 4.90 per cent or less. No glauconite sand was found in Tennessee in the area from which it had been reported by Troost.[1] Since the above was written it has been learned that a little greensand containing not over 3 per cent of potash has been found by Mr. Bruce Wade in McNairy County, Tenn., at the foot of a hill west of Adamsville."

"Origin and Nature of Greensand

"The origin of greensand is still somewhat in doubt, but there is good reason for believing that it is a product of the alteration of clay or feld-

[1]Troost, Gerard, Seventh report of the Geological Survey of Tennessee, p. 1844.

spar, particularly clay. The steps assumed by Murray and Irvine[1] are, first, the formation of iron sulphide in sea water in the presence of decomposing vegetable matter and, second, the replacement of the aluminum of the clay by this iron, resulting in a compound that combines with the potash in sea water to form glauconite, the potash in the sea water having been derived from potash feldspars, mica, and other potash bearing minerals that are brought into the sea. Some water also enters into the glauconite molecule. According to Murray and Renard,[2] the sulphates in sea water act on the iron in mud or clay in the presence of organic matter, producing iron sulphide, which later oxidizes to the hydroxide. At the same time the alumina is removed from the clay by solution, and colloidal silica is liberated, which reacts upon the ferric hydroxide in the presence of potassium salts extracted from the adjacent minerals, the reaction forming glauconite.

"As a consequence of variations in the conditions under which glauconite is formed the process of formation does not appear to be very uniform or to produce a single definite compound, for the alumina may not be completely removed and the potassium may be in part replaced by other bases. If the glauconite were pure and had the formula suggested by Dana, $Fe'''KSi_2O_6+3H_2O$, it should contain 13 per cent of potash. As a matter of fact, the analyses quoted indicate that some of the potassium is always replaced by other bases.

"The most common type of glauconite consists of minute botryoidal pellets whose forms are due, apparently, to the fact that the clay from which they were derived occupied cavities in minute shells. The pellets in another type are round and smooth, as if they had been derived by erosion and redeposition from a deposit of the first type. A third type, which includes glauconite stains and the grains that fill crevices and cavities, may be due, in part, to the alteration of grains of feldspar.

"Glauconite is found in deposits on the sea bottom at depths ranging from about 300 feet to 2 miles.

"Recently formed glauconite is well described and illustrated in the report of the *Challenger* expedition.[3] Some of the deposits found by that expedition were almost pure glauconite. Most of the deposits found, however, contained from 40 to 50 per cent of foraminiferous and other calcitic shells. The grains of recent glauconite rarely if ever exceed 1 millimeter in diameter, and are typically rounded or mammillated, hard, and black or dark green. The surface of some of the grains is dull, that of others is shiny. Many of the grains have vaguely the form and appearance of Foraminifera and other organisms. Mixed with these typical grains are many pale-green particles that have the distinct impress of calcareous shells, many being obviously internal casts."

"North Carolina

"The Greensand of North Carolina was sampled at only one locality—a bluff one mile above Edwards Bridge, on the north side of Contentnea Creek, about 6 miles above Grifton, a station on the Atlantic Coast Line Railroad

[1]Collect, L. W., Les depots marins, p. 169, Paris, 1908. See also Murray, John, and Irvine, Robert, On the chemical changes which take place in the composition of the sea water associated with blue muds on the floor of the ocean. Roy. Soc. Edinburgh Trans. vol. 27, pt. 3, 1893.

[2]Murray, J., and Renard, A. F., Challenger Rept., Deep-sea deposits, p. 389, 1891.

[3]Idem, pp. 378 et seq.

a few miles northeast of Kingston. The greensand at this point was said by L. W. Stephenson to appear to be much greener than any other that he had seen in the State. It is overlain by 6 to 8 feet of clay and yellow sand and gravel. The richer portion of the sand is 4 feet thick. Sample 43, taken at this locality, is a light-greenish sand, containing considerable quartz. Below the layer sampled lies 8 feet of dark-gray sand, which here and there contains small stringers of greensand a few inches long and less than an inch thick. Sample 44 represents a 7-foot cut in this bed.

"The greensand is reported to have been struck in ditches some distance north and east of this bluff. About a quarter of a mile above Edwards Bridge, nearly 5 feet of the lower bed is exposed in a bluff on the north bank. The greensand is overlain directly by the surface sand and gravel. The lower bed at this point is represented in sample 45."

Results of analyses of samples collected from North Carolina are as follows:

Analyses of Greensands

(By W. B. Hicks and R. K. Bailey, Analysts.)

No.	Locality	Potassium	Potash	Analyst
43	Contentnea Creek, N. C.	2.46	2.96	Bailey.
44	Contentnea Creek, N. C.	1.14	1.37	Bailey.
45	Contentnea Creek, N. C.	1.12	1.35	Bailey.

STONE

The development of the stone industry in North Carolina has been most interesting, and the production has increased almost constantly from year to year since the industry began to be thoroughly advertised and the various stones became known. In 1897 the value of the stone produced in North Carolina was less than $75,000; in 1916, the year of record production, the total production of stone reached near $2,000,000. This has been due in large part to the increase in the production of granite. Under the head of "Stone" is included all granite, no matter for what purpose used; sandstone; marble and other forms of limestone, including that which is made into lime or used as limestone for agricultural purposes, this also including the marls of the Coastal Plain. In recent years stone has come to be used very largely in the making of concrete, and a large proportion of the stone from some of the quarries is used entirely for this purpose. The manufacture of paving blocks has also grown very extensively, and many of the companies are developing certain types of block under trade names. In the table below there is given the value of the production of the various stones produced in North Carolina from the year 1900 to 1917, inclusive:

PRODUCTION OF BUILDING STONES IN NORTH CAROLINA, 1900—1917.

Year	Granite	Sandstone	Marble and Limestone	Total Value
	Value	*Value*	*Value*	
1900	$ 257,962	$ 27,210	$*----------	$ 285,172
1901	264,906	11,682	8,357	284,945
1902	338,749	4,825	23,153	366,727
1903	334,357	600	25,365	360,322
1904	292,439	250	19,887	312,576
1905	564,425	4,482	29,015	597,922
1906	778,819	3,431	72,051	854,301
1907	906,476	4,105	46,338	956,919
1908	771,522	†----------	53,405	824,927
1909	743,876	----------	106,931	850,807
1910	837,742	†----------	77,585	920,027
1911	772,685	†----------	81,651	864,071
1912	983,615	†----------	100,766	1,090,831
1913	1,116,475	†----------	140,364	1,260,339
1914	1,286,345	†----------	154,888	1,452,405
1915	1,246,810	27,544	164,344	1,438,698
1916	1,798,087	†----------	176,164	2,026,782
1917	1,486,541	†----------	‡ 233,950	‡ 1,948,539

*Statistics not collected for 1900. †Included in total production. ‡Includes a production of Rhyolite.

Granite

The largest and most extensively worked granite area in the State is the Mt. Airy granite area in Surry County, North Carolina. This has been described in considerable detail in Bulletin 2 and Economic Paper 34 of the publications of the North Carolina Geological and Economic Survey, as well as other important granite areas of the State.

Production

During 1913 there were 27 operators who quarried in the following eleven counties, given in the order of the importance of their productions: Surry, Rowan, Mecklenburg, Rockingham, Buncombe, Warren, Polk, Vance, Wilson, Gaston and Henderson. The value of the 1913 production was $1,116,475.

In 1914 there were 38 operators who quarried in the following sixteen counties, given in the order of the importance of their productions: Surry, Rowan, Stanly, Rockingham, Wake, Mecklenburg, Davidson, Wilson, Polk, Buncombe, Warren, Catawba, Henderson, Forsyth, Vance and Gaston. The value of the 1914 production amounted to $1,286,345.

In 1915 there were 30 operators in the following counties, given in the order of the importance of their productions: Surry, Rowan, Catawba, Rockingham, Wilson, Wake, Davidson, Henderson, Meck-

lenburg, Vance, Forsyth, Buncombe and Gaston. The value of the 1915 production amounted to $1,246,810.

In 1916 there were 39 operators in 13 counties, as follows, given in the order of the importance of their productions: Rowan, Surry, Stanly, Wilson, Vance, Rockingham, Henderson, Mecklenburg, Buncombe, Warren, Wake, Gaston and Alamance. It will be noted from the above order that Rowan takes first place in production over Surry for the first time. The value of the 1916 production amounted to $1,798,087.

In 1917 there were 33 producers from eleven counties, as follows, given in the order of the importance of their productions: Rowan, Surry, Wilson, Rockingham, Henderson, Wake, Vance, Mecklenburg, Buncombe, Cleveland and Gaston. The value of the 1917 production was $1,486,541, a slight decrease from the 1916 production, which was due to a falling off in the amount of granite quarried for use in concrete, and a slight reduction in the production of granite for building and monumental purposes. There has been a steady increase in the production of granite for making paving blocks.

In the following table there are given the use and value of granite produced from 1912 to 1917, inclusive:

USES OF GRANITE PRODUCED IN NORTH CAROLINA 1912—1917, INCLUSIVE.

Uses	1912	1913	1914	1915	1916	1917
Building and monumental purposes	$315,088	$408,931	$483,733	$417,721	$462,014	$ 406,073
Paving blocks	212,990	215,133	243,314	191,796	200,851	204,690
Curbing and flagging	135,016	92,240	87,286	89,222	124,845	160,663
Crushed stone for macadam, railroad ballast, etc	105,879	162,632	158,645	243,987	401,893	270,788
Concrete	206,579	235,548	308,884	302,084	558,476	340,624
Other purposes	8,063	1,991	4,483	2,000	50,008	103,703
Totals	$983,615	1,116,475	1,286,345	1,246,810	1,798,087	1,486,541

The next table gives the value of granite produced from 1897 to 1917, inclusive; which shows very strikingly the remarkable growth of this industry in the State. The 1916 production is the greatest production of granite reported for any one year:

PRODUCTION OF GRANITE IN NORTH CAROLINA, 1897—1917.

Year	Value
1897	$ 59,236
1898	79,969
1899	225,544
1900	257,962
1901	264,906
1902	338,749
1903	334,357
1904	292,439
1905	564,425
1906	778,819
1907	906,476
1908	764,272
1909	743,376
1910	839,742
1911	772,685
1912	983,615
1913	1,116,475
1914	1,286,345
1915	1,246,810
1916	1,798,087
1917	1,486,541

Sandstone

The sandstones in North Carolina that have been quarried are from the triassic areas extending across the State in varying widths and covering portions of Granville, Durham, Orange, Wake, Chatham, Harnett, Lee, Moore, Montgomery and Anson counties. There is a similar belt of this sandstone which extends across a part of Rockingham, Stokes and Forsyth counties. The color of these sandstones varies somewhat throughout the belt, but it is usually reddish brown and sometimes a rather grayish brown.

In 1913 there was one producer of sandstone in Anson County. In 1914 there were two producers, one from Lee County and one from Mecklenburg. In 1915 there were three producers, one from Anson, one from Lee, and one from Gaston County. The 1915 production was valued at $27,544 and was used for road metal, railroad ballast and concrete. In 1916 there were only two producers, one from Anson and one from Gaston County. In 1917 there was only one producer, from Lee County. A large proportion of the output from this quarry was used for building purposes, and a small quantity for rubble.

The figures regarding the production of sandstone cannot be given except in combinations, because in most years the number of producers numbered less than three.

Rhyolite

There has recently been opened a quarry at Ball Mountain near Newsom, on the Winston-Salem Southbound Railway, of the trap rock rhyolite. The main line of the railroad runs at the foot of the mountain containing the quarry, and the machinery for manufacturing the stone is located on a siding paralleling the main line. The plant is located about the center of the quarry which faces the main line of the Southbound and the Yadkin River for some two thousand feet. It has an operating face 1,000 feet long and about 60 feet high. Four samples of this material were analyzed by Mr. J. H. Gibboney, chemist, to ascertain whether or not they contained plant food in sufficient amount to render them valuable for agricultural purposes. The following are the results of the tests made:

ROANOKE, VA., January 3, 1916.

"MR. W. H. LEWIS,
Superintendent Motive Power.

Dear Sir:

"The attached letters from Mr. Maher, of December 7th, and 15th, referring to 4 samples of stone from Ball Mountain Quarry, sent in by Mr. Fries, President of the Winston-Salem Southbound Railway, for examination, to ascertain whether or not they contained plant food in sufficient amount to render them valuable for agricultural purposes.

"Our results follow:

	No. 1	No. 2	No. 3	No. 4
	Per cent	*Per cent*	*Per cent*	*Per cent*
Silica	72.84	21.24	71.48	60.60
Iron oxide	4.47	4.66	4.47	8.79
Aluminum oxide	14.25	17.26	14.45	19.25
Calcium oxide	1.20	1.28	5.44	1.80
Magnesium oxide	.55	.61	.71	2.63
Sodium oxide	3.43	2.49	.60	1.73
Potassium oxide	3.07	1.90	.35	2.01
Loss on ignition	.14	.36	2.38	3.09
Undetermined	.05	.20	.12	.10

No. 1—Rhyolite from main face of quarry.
No. 2—Rhyolite from slide North of crushing plant.
No. 3—Altered rhyolite from North face.
No. 4—Basalt from North face.

"The only element of direct plant food present in these stones is the potassium, expressed by us as the oxide, but actually present in the stone mass as the silicate. Under certain conditions of treatment or soil reactions this material can be rendered available as a direct fertilizer; however, in our opinion, these particular stones are far too low in potassium to render them of value for agricultural purposes." (Signed) "J. H. GIBBONY,
"CHEMIST."

As there was only one producer of rhyolite in the State, the figures cannot be given here, but are included under the total stone production. The material was used for railroad ballast and concrete.

Marble and Other Forms of Limestone

Marble.

In the report on the mining industry for 1910 a detailed description of the marbles of the Nantahala area is given.

A brief visit was made in the summer of 1917 by Mr. John E. Smith, geologist for the Survey, to the marble quarries at Regal, Cherokee County, and Hewitts, Swain County. Mr. Smith made the following report:

"Regal, Cherokee County, North Carolina: Regal Marble Company, D. J. Deschler, Asheville, President; R. C. Boylan, Regal, Superintendent. A new quarry was opened three years ago. This rock is a part of the formation known as Murphy Marble, and is of Cambrian age. The bedding plains dip to the southeast steeply. It is quite solid and compact, and blocks 4 to 6 feet, up to a maximum of 4x13 feet, were seen on the yard. The cutting is done by four Sullivan and Ingersoll channelers and the large blocks of marble are moved by means of a crane.

"About 60 men are employed and nearly 1,000 cubic feet of marble is used daily. The product consists of two grades, known as Regal Blue and Confederate Gray; both of which are very high in quality. The equipment is complete, and consists of 7 cross cut gang saws; circular rubbing beds; turning lathe; circular saws, and other polishing and finishing implements driven by compressed air.

"The product consists chiefly of grave stones and ornamental work, and is sold in nearly every state in the Union, also in Canada and Mexico. Stones crated and labeled for shipment were seen in the shipping room. They go to the following states: Ohio, Michigan, Virginia, Indiana, Washington, Oklahoma, Iowa, Texas, Illinois, and to numerous points in nearby states. The company ships about 1 carload of finished product per week.

"Hewitts, Swain County, North Carolina: North Carolina Talc and Mining Company is operating the quarry and producing crushed stone for use in concrete work. The crusher is operated by water power—a 280-horsepower water wheel. This power also furnished electric lights in all of the company's buildings.

"A lime kiln having a capacity of 70 tons per week has been leased to the Interstate Lime Company, of Bristol, Virginia, and was operated about 3 months during 1917, closing in May. The limestone is of high quality, yielding about 97 per cent pure burned lime—a waste of only 3 per cent of the quarry material in burning. Much difficulty is experienced in obtaining cars in which to ship the materials produced at Hewitts."

Limestone.

The limestone figures given in this report refer also to the marl produced in the Coastal Plain and which is used largely for fertilizer

purposes. An investigation is now under way by the Geological Survey of the marls and limestones of the State which will give in detail information in regard to these various deposits.

In 1913 there were eight producers of limestone from the following counties, given in the order of the importance of their productions: Henderson, Madison, New Hanover, Swain, Cherokee, Columbus, Craven and Beaufort.

In 1914 there were eight producers from the following eight counties, given in the order of the importance of their productions: Henderson, Madison, New Hanover, Cherokee, Swain, Craven, Yadkin and Surry.

In 1915 there were eight producers from the following nine counties, given in the order of the importance of their productions: Henderson, Madison, Cherokee, Craven, New Hanover, Yadkin, Surry, Columbus and Swain.

In 1916 there were eight producers from the following eight counties, given in the order of the importance of their productions: Henderson, Madison, Jones, Craven, Swain, McDowell, Yadkin, and Cherokee.

In 1917 there were seven producers from the following seven counties, given in the order of the importance of their productions: Henderson, Madison, Jones, Columbus, McDowell, Swain and Craven. The 1917 production was used largely for agricultural purposes, the smaller amounts being used for concrete, road making, flux, tanneries, and building purposes.

Production

There is given in the table below the value of the production of marble and other forms of limestone from 1901 to 1917, inclusive:

PRODUCTION OF MARBLE AND OTHER FORMS OF LIMESTONE, 1901—1917.

Year	Value
1901	$ 8,357
1902	23,153
1903	25,365
1904	19,887
1905	29,015
1906	72,051
1907	46,338
1908	53,405
1909	106,931
1910	77,585
1911	81,651
1912	100,766
1913	140,364
1914	154,888
1915	164,344
1916	176,164
1917	233,950

Stone Producers During 1917

Granite

County	*Name*	*Address*
Buncombe	Ardmion Park Quarry Co.	Asheville, N. C.
	French Broad Quarry Co.	Asheville, N. C.
	Smith & Carver Development Co.	Asheville, N. C.
Cleveland	S. N. Lattimore	Shelby, N. C.
Gaston	Chas. M. Friday	Dallas, N. C.
	William Lockhart and J. P. Hoffman	Gastonia, N. C.
Henderson	W. B. Valentine, Lessee, Balfour Quarry Co.	Asheville, N. C.
	W. A. Smith	Hendersonville, N. C.
	Wright & Dixon	Hendersonville, N. C. (Mecklenburg Co.)
	Atlantic Bitulithic Co.	Charlotte, N. C.
	Charlotte Paving Co.	Charlotte, N. C.
Rockingham	Harris Granite Quarries Co.	Salisbury, N. C.
Rowan	Blue Pearl Granite Co.	Winston-Salem, N. C.
	J. T. Artz	Salisbury, N. C., R. 3
	Casper Barnes	Faith, N. C.
	Faith Granite Co.	Salisbury, N. C., R. 3
	Ganley Bros.	Salisbury, N. C., R. 3
	Byrd Bros.	Salisbury, N. C., R. 3
	Harris Granite Quarries	Salisbury, N. C.
	Hudson & Brown	Granite Quarry, N. C.
	Central Contracting Co., care Geo. R. Collins	Salisbury, N. C.
	John Parry	Granite Quarry, N. C.
	Robert Roberts	Granite Quarry, N. C.
	William Smith	Salisbury, N. C., R. 3
	B. C. Eagle	Salisbury, N. C., R. 3
	Salisbury Granite Corporation	Salisbury, N. C.
	J. T. Wyatt Granite Works	Salisbury, N. C., R. 3
Surry	North Carolina Granite Corp.	Mount Airy, N. C.
Vance	Raleigh Granite Quarry	Raleigh, N. C.
	Matthews Granite Quarries Co.	Knightsdale, N. C.
Wake	Raleigh Granite Co.	Raleigh, N. C.
Wilson	Harris Granite Quarries Co.	Salisbury, N. C.

Lime and Limestone

Avery	Clinchfield Lime Co.	Linville Falls, N. C.
Columbus	N. C. Department of Agriculture	Raleigh, N. C.
Craven	Lovit Hines	Kinston, N. C.
	Trent River Marl & Lime Co.	Pollocksville, N. C.
Henderson	Blue Ridge Lime Co.	Asheville and Fletcher, N. C.

County	*Name*	*Address*
Madison	The G. C. Buquo Lime Co.	Hot Springs, N. C.
Swain	N. C. Talc & Mining Co.	Hewitts, N. C.

MARBLE

	Regal Marble Co.	Regal, Cherokee County, N. C.

SANDSTONE

Anson	John T. Patrick	Wadesboro, N. C.
Lee	Capital Stone Co.	Sanford, N. C.
Gaston	Carolina Stone Co.	Columbus, Ga.
	Hardaway Contracting Co.	Bridgewater, N. C.

RHYOLITE

	Ball Mountain Stone Co.	Newsom, Madison County, N. C.

SAND AND GRAVEL

The sand and gravel marketed in North Carolina consists chiefly of building sand, gravel for railroad ballast, engine sand, paving sand, gravel for road making, and a small quantity of sand for grinding and polishing. So far, no glass sand has been put on the market from this State, though there are undoubtedly deposits of sand in North Carolina which could be used for this purpose.

"REQUIREMENTS OF GLASS SAND.

"The factors which determine the value of a deposit for making glass are chemical purity, physical character, quarrying conditions, and location with respect to transportation, cheap fuel, and market.

"Glass is a transparent impermeable substance formed by fusing sand, or silica, with fixed alkalies. It is made by melting the ingredients in a pot or tank, mixing the batch thoroughly, and allowing it to cool. It is molded into the desired form while molten. Sand is the principal constituent of all glass, comprising from 52 to 65 per cent of the mass of the original mixture. The qualities of the glass, such as lack of color, brilliance, transparency, and hardness, depend largely, therefore, on the quality of the sand.

"For the finest ware only the purest quartz (silica) sand can be employed because slight impurity, especially a small quantity of iron, impairs the brilliance, whiteness, and clearness. Thus, for the manufacture of glass for optical instruments, which is practically colorless, sand, or ground silica, should contain not more than 0.015 per cent of

ferric oxide. Plate and window glass are commonly pale green and absolute purity is not essential in the sand, but more than 0.2 per cent of ferric oxide is undesirable. Green and amber glass for rough structural work, as skylights, sidewalk lights, for bottles, jars, and insulators, are made from sand that has more impurity than is permissible in sand for plate glass and prescription ware.

"The suitability of a sand for making glass may be determined roughly by inspecting it for the following properties: The sand should consist almost entirely of quartz, or silica (most glass sands contain from 98 to more than 99 per cent of silica); it should be nearly white or easily washed white; the grains should be uniform in size, either angular or rounded, and preferably should not be larger than 20 mesh nor smaller than 80 mesh. Whiteness is not essential, however, in sand for ordinary window glass and cheap bottles and jars. Sand for window glass that has been dug at a New York locality for many years is pink or dark flesh-colored, and an Indiana sand used for making beer bottles is drab, because of a coating of clay on each of the colorless quartz grains.

"Most of the glass sand produced in this country is obtained by crushing soft, crumbly sandstones, but where power is very cheap, it is practicable to produce glass sand by crushing quartzite and vein quartz.

"Methods of quarrying and preparing the sand vary somewhat, but in general the quarry face is drilled and shot down with an explosive, and the coarse and fine material is delivered to the mill. If a special quality of sand is desired, selection may be made at the quarry by hand sorting. Large lumps, if very hard, are reduced by a jaw or rotary crusher, but in most places by a less powerful machine, such as a pug mill or muller or a crusher consisting of many heavy hammers revolving rapidly.

"Washing the crushed sand is done by two common methods. By one method the sand is carried first upward by a screw conveyor through a long, narrow inclined box against a descending stream of water and then downward in a narrow chute by a second stream of water. This process is repeated three or four times, after which the sand is spilled on a belt conveyor and carried to the draining piles. Another method of washing is by settling tanks. A stream of sand and water is discharged into a tank where the sand settles and impurities are drained off. Sand washed by this method may be left in the last tank to drain, or it may be carried to a draining pile. Sand carried away by the wash water in either process is caught in settling ponds or yards outside the mill and may be used for the various purposes to which a fine-grained silica sand is adapted.

"After draining for several hours, or days, the sand is dried, either rapidly in rotary cylindrical driers heated by gases from coke or other smokeless fuel, or slowly by settling through coils of steam pipes, and is then screened and put in stock bins. Glass sand is shipped in bulk in box cars, which are lined with paper to prevent leakage."

"Building Sand.

"Building sand is used for making plaster, mortar, and concrete. Wall and ceiling plaster, whether made of lime or gypsum, commonly contains a considerable quantity of sand, particularly in the base coat. Mortar used in laying brick, stone, and tile has a body of sand, and sand is a large constituent of much concrete. The reported production of building sand increases annually by reason of larger business and new names added to the list of producers. This sand probably is reported less completely than any other in the foregoing tables because its occurrence is common and widespread, and its use in small amounts by thousands of individuals is not reported to the Survey. The individual use often is only a wagon load or a few tons, but the aggregate of these of which the Survey gets no record must be hundreds of thousands of tons. In many small villages throughout the United States there is no regular dealer in sand and whoever needs a supply gets it from a local deposit. This may be a privately owned sand pit from which the owner may derive a few dollars a year, or it may be the dry bed of a stream from which sand is taken without charge."

"Grinding and Polishing Sand.

"Grinding and polishing sands are sharp, tough, hard sands free from clay or foreign material, and sized for use in sawing, cutting, and polishing stone, for grinding and etching glass, and for cleaning metal castings by means of a blast. Blast sand may be either round or angular grains."

Production

Sand and gravel produced in North Carolina as reported to the Geological Survey is from the following counties: Anson, Buncombe, Burke, Cleveland, Columbus, Cumberland, Gaston, Guilford, Halifax, Harnett, Henderson, Iredell, Mecklenburg, Montgomery, Moore, Northampton, Pender, Robeson, Scotland, Wake, Wayne, Wilkes and Wilson.

The following table gives the value of the production of sand and gravel in North Carolina from 1905 to 1917, inclusive, and the quantity produced from 1912 to 1917:

PRODUCTION OF SAND AND GRAVEL IN NORTH CAROLINA, 1905—1917, INCLUSIVE.

Year	Quantity Short Tons	Value
1905		$ 547
1906		9,191
1907		2,191
1908		2,070
1909		13,358
1910		13,406
1911		93,336
1912	161,198	38,487
1913	400,577	127,574
1914	492,092	72,989
1915	424,740	124,697
1916	554,381	150,209
1917	543,364	231,813

Producers

The following were producers of sand and gravel during the past five years:

Hardaway Contracting Co., Bridgewater, Burke County.
W. R. Bonsal & Co., Lilesville, Anson County.
Asheville Sand Co., Asheville, Buncombe County.
Cape Fear Gravel Co., Inc., Norfolk, Va. (Harnett County)
Riverside Sand Co., Charlotte, N. C. (Pit at Mt. Holly, Gaston Co.)
Atlantic Coast Line, Halifax County.
The Gale Sand Co., Green Pond, Scotland County.
Valentine & Co., Asheville, Buncombe County.
Balfour Quarry Co., Asheville, Buncombe County.
J. V. Wallace, North Wilkesboro, Wilkes County.

SAND LIME BRICK

As there has been no production of sand lime brick in North Carolina since 1912, the table of production is discontinued in this report.

CLAY AND CLAY PRODUCTS

With the exception of kaolin, all of which is shipped out of the State, there is but little clay which is mined and put on the market as a raw product. The bulk of the value of clay products given in the tables beyond represents the value of the products manufactured from the clay, and of those manufactured products, common brick represent by far the largest value. There has been a steady increase in the number and value of the brick produced and in the production of kaolin. With the large increase in the production of feldspar in west-

ern North Carolina and the tremendous demand for clay brought about by the war, there has been a growing interest in the development of clay deposits.

Production

There is given in the following tables the total production of clay products in North Carolina for the years 1912 to 1917, inclusive:

VALUE OF CLAY PRODUCTION IN NORTH CAROLINA FROM 1912—1917, INCLUSIVE

	1912		1913		1914	
	Quantity	Value	Quantity	Value	Quantity	Value
Common brick	193,058,000	$1,236,443	204,097,000	$1,354,062	183,648,000	$ 1,216,180
Front brick	1,131,000	10,085	1,772,000	15,757	1,310,000	14,964
Fire brick	324,000	4,430				
Earthenware		778		2,318		1,477
Stoneware		8,172		10,365		11,078
Miscellaneous ware				1,000		241
Sewer pipe, tile, etc.		205,745		230,904		216,850
	Tons		*Tons*		*Tons*	
Kaolin	14,950	109,717	16,332	139,629	17,168	164,334
Fire and pipe clays	20	104	20	15	605	303
Total values		1,605,474		1,754,050		1,625,427

	1915		1916		1917	
	Quantity	Value	Quantity	Value	Quantity	Value
Common brick	140,257,000	$ 862,391	193,264,000	$1,234,926	172,842,000	$ 1,346,211
Front brick	1,080,000	10,250	2,300,000	23,650	1,481,000	16,621
Fire brick	*				*	
Earthenware		2,504		1,290		1,269
Stoneware		8,190		7,805		5,756
Miscellaneous ware		700		765		450
Sewer pipe, tile, etc.		205,100		283,000		292,000
	Tons		*Tons*		*Tons*	
Kaolin	15,699	143,505	17,392	151,688	17,426	182,176
Fire and pipe clays	370	191	170	135		
Total values		1,232,831		1,703,259		1,844,483

*Included under front brick.

As stated above, these tables probably do not represent the total output of clay products throughout the State, for the reason that in a number of the counties there were a few thousand brick made for local purposes, regarding which it is extremely difficult or impossible to obtain statistics. This is especially true where the brick are not for sale but are for use by the manufacturer; and it may be a year or more before he manufactures any more.

The Geological Survey has in preparation a report on the clay deposits of the State which will be supplementary to the data contained in Bulletin 13 on the "Clay Deposits and Clay Industries in North Carolina."

Clay Tests

In 1917, the Survey began a series of tests in coöperation with the Bureau of Standards, U. S. Department of Commerce, at Pittsburgh, Pa. These tests were to be made on a number of clay samples, but the work was interrupted by war work. Tests were made, however, on four samples, as follows:

"167R. R. L. Steele, Rockingham, N. C.
180R. Cask of red clay from W. N. Garrett, Hot Springs, N. C.
193R. Marked No. 5. Jesse Bare, Box 49, R. 2, Crumpler, N. C.
216R. J. E. Coburn, Bryson, N. C.

"In order to make the tests more complete, chemical analyses were made and are as follows:

	167R	180R	193R	216R
Silica	69.29	55.44	49.61	48.08
Alumina	20.43	19.84	35.80	38.03
Iron oxide	1.67	8.54	1.57	.22
Calcium oxide	.32	.35	.20	.27
Magnesium oxide	.61	5.05	1.90	.04
Potassium oxide	2.67	7.55	.30	----------
Sodium oxide	.34	.60	.38	----------
Loss on ignition	4.91	3.00	11.32	13.69
Totals	100.28	100.37	100.14	100.33

"167R. R. L. Steele, Rockingham, N. C.

"This clay is a hard, short, non-plastic clay very difficult to make up into discs on account of its shortness and also very difficult to handle after drying. The material burns similar to kaolins but is of a poor color. When made up into a white ware body and glazed, it burns to a grey color that would make it of no commercial value for white ware. However it makes a pleasing shade of grey which might be of use in developing some artistic ware.

"The body used in this, as well as the other clays, is described below.

"180R. Cask of red clay from W. N. Garrett, Hot Springs, N. C.

"This clay is a hard homogeneous red clay of fine quality. On account of its hardness it had to be ground in a ball mill to reduce it to a slip. In trying to cast the ware it was necessary to add 25% of fire clay to

reduce the shrinkage. The pure clay required 38.9% of water in terms of the dry weight, for proper working. Drying shrinkage 12.78% in terms of the dry volume. A sample burned to 1180°C. had a volume shrinkage of 5.61% in terms of the dry volume. The color at different temperatures is as follows:

1000°C. Salmon color, very porous.
1100°C. Light red, porous.
1150°C. Brick red, less porous.
1200°C. Chocolate color, vitreous.
1250°C. Black, overburned and out of shape.

"Burned at 1180° the absorption is 13%. The vitrification range appears to be much too narrow to permit the use of this clay for the manufacture of paving brick. The discs being sent you were burned at 1100°C.

"193R. Jesse Bare, Crumpler, N. C., R. F. D. 2

"This clay consisted of medium hard white lumps showing some brownish stains on the surface. The plasticity of this clay is very low and the discs cracked in drying. The clay required 38% of water. When fired to cone 14 in a kiln fired with natural gas, the color obtained was an excellent white. In drying the volume contraction was 15% in terms of the dry volume. The contraction in burning to cone 14 was 38% in terms of the dry volume.

"In the screen tests a residue of 48% was found on the 100-mesh sieve, 6% on the 150-mesh, 7% on the 200-mesh, 6% on the 300, and 41% passed the 300-mesh. In order to use this material it would have to be ground in a ball mill in order to develop sufficient plasticity for working purposes. This clay behaved very much like a holloysite. Its desirable color is the greatest point in its favor. See samples of the straight clay, also when made up in a body and glazed.

"216R. J. E. Coburn, Bryson City, N. C.

"This clay was also of a sandy nature and high in mica. Its color was white. It was found to be lacking in plasticity to a considerable extent and required ball mill grinding to make it suitable for use. The water of plasticity required was 35%. Its dry shrinkage was 17.5% in terms of the dry volume. Its firing shrinkage to cone 14 was 29% by volume in terms of the dry volume. In the sieve test it left a residue of 6% on the 100-mesh sieve, 1% on the 150, .3% on the 200, .1% on the 300, and 89% passed the last sieve. The principal point in connection with this clay is its beautiful white color which should make it attractive for pottery manufacture.

Manufacture of Ware

"The glazed ware is made up similar to a white ware body. In each case the body contained 28% of the clay under test. The rest of the mixture being made up of standard white ware materials. All ware was biscuited at cone 10. Part of the ware was glazed at cone 4 with white ware glaze and the rest glazed at cone 10 with a glaze corresponding to the formula for cone 4. There are some slight defects in the ware which could of course be overcome, if made in quantity and sorted."

Kaolin

There has been a steadily growing interest in the production of clays in the United States since the war began and the importation of English and German clays has been cut off. This is particularly true in regard to the finer grades of clay constituting china clays or kaolins. While the main source of the American kaolin is in the Southern States, no white ware pottery is made in the South, the three leading states in the manufacture of such products being Ohio, New Jersey, and West Virginia.

Several grades of pottery are made in the United States, varying from ordinary stoneware to the finest porcelains. In the lower grades of stoneware and Rockingham ware, ordinary clays are used, usually those found in the section where the potteries are located. The cream-colored ware is made from a mixture of low grade kaolin and ball clays. White granite, or ironstone china, is made of a purer grade of kaolin mixed with quartz and feldspar. A special variety of this ware is the sanitary pottery, such as wash bowls, bath tubs, etc. Another grade which is rapidly increasing in output is the electrical line, made up of fuse boxes, insulators, insulator tubes, etc. China or porcelain is made from the finest and purest materials. The thinner varieties are known as porcelain, though in American practice the term porcelain is more often applied to the semi-vitreous white granite ware. The essential components of white granite are kaolin, quartz and feldspar. To illustrate the mixture, the following proportions are used in two different plants:

	Parts	*Parts*
Kaolin	48.44	58.56
Quartz	45.36	30.36
Feldspar	5.20	11.08

The two great centers for the white ware pottery industry in this country are East Liverpool, Ohio, and adjoining portions of West Virginia, Pennsylvania, and Trenton, New Jersey. These plants all use a mixture of clays from Cornwall, England, South Carolina and Georgia.

In western North Carolina, in Mitchell, Yancey, Swain and Jackson counties, in the territory tributary to the Carolina, Clinchfield and Ohio Railroad, the Tallulah Falls and the Southern Railroads, are found the pegmatitic dikes cutting through the schist rocks of that area. In these dikes occur, in addition to the valuable mica deposits, the essential components of white ware and china pottery—the quartz, the feldspar, and kaolin. The prospecting and mining for mica through the past years has opened many kaolin deposits of value. Mica was regarded as the all-important mineral and the one from which quicker cash results could be realized. From these various mica mines and mica prospect pits and tunnels can be traced today the kaolin deposits over this area.

Kaolin is a secondary mineral in these dikes, and in all deposits of economic importance, has resulted from the decay and breaking down of feldspar. Mingled with this secondary kaolin occurs the quartz and mica minerals and the original pegmatite, as well as more or less partly altered feldspar. Near the surface of the dike the kaolin will be stained with the iron and other surface impurities. This change may extend to considerable depth. Some of the kaolin mines in this area have been worked to a depth of 150 feet and still show good kaolin.

The following extracts from a paper by G. P. Grimsley, in the *Manufacturer's Record* of June 18, 1914, will be of interest:

"In the preparation of the kaolin taken from these mines for the market, it is very important that they should be freed from these other minerals of the dike. Mica interferes with the plastic and tensile properties of the kaolin in pottery mixtures, and is also liable to color the ware by its iron content. Quartz being almost infusible lowers the shrinkage in drying and burning clays, and so is a most important part of the pottery mixture; but its variable quantity in the clays and in different portions of the kaolin would cause the potter so much trouble that it must be removed from the kaolin for market and then added as required by the potter. The removal of these impurities is the great problem in the preparation of kaolin for the market.

"A pure kaolin clay is white in color, with soapy feel, earthy fracture fusing or melting at about 2300°F., shows 2 to 5 per cent air shrinkage, with tensile strength of 8 to 25 pounds, and specific gravity of two and six-tenths.

"The kaolin as taken from the mines contains a large amount of very fine mica flakes and small quartz grains, which must be removed. In a number of analyses of the mine kaolins it was shown that there was present about 25 to 30 per cent kaolin, and the residue was impurities to

be removed. The present methods of refining this product yield about half of the kaolin, the other half being lost in the process of washing. In the mines of western North Carolina the kaolin is conveyed from the mine by a water flume to the washing plant. The kaolin is washed by passing it into a rectangular box, where it is stirred and thoroughly mixed in the water by revolving arms carrying wooden paddles. The clay is run from the washer to the sand wheel boxes. To the spokes of these wheels are attached iron cups or boxes open at the lower end with a sloping rim to the outer edge of the tank. The revolution of the wheel takes up from the bottom of the box the lumps of foreign material which at the upper position of the cups slides by the sloping rim to outside of box. The kaolin and fine particles of impurities pass in a flow of water to the sand trough, which is a couple of feet wide and 20 or more feet along, set nearly level in position. The slow movement of the solution in this level trough permits settling of most of the quartz sand and coarser mica.

"The kaolin bearing water passes from the sand trough into the mica troughs, arranged in a series, so that the solution passes in at one end and out at the other into the second mica trough, and back at the opposite end into the third, and so on. The flow through these troughs is produced by slightly tilting them. The troughs are one foot square and of varying length in different plants, 25 feet or more. From the mica troughs the kaolin water is passed over a series of stationary fine brass screens set sloping, in order to remove any fine flakes of mica left. From the screens the kaolin passes to concentrating tanks, where the kaolin settles to bottom and the excess water is drawn off. This settling is hastened by suspending alum in muslin bags in the tanks. The kaolin after settling is run into a circular agitator tank in which a vertical shaft with attached paddles rotates and thoroughly mixes the kaolin for the purpose of insuring a uniform product.

"From the agitator the kaolin is pumped under pressure into ordinary clay filter presses composed of a series of canvas bags in which the surplus water is forced out by the heavy pressure. The clay sheets removed from this filter press are carried to a steam drying shed and thoroughly dried, ready for shipment.

"By the above method of washing the kaolin from these mines, there is always danger of not removing all the fine mica. The presence of such fine mica flakes in the kaolin lowers its value. It is claimed in a number of large potteries that the foreign kaolins are more uniformly prepared and are always free from impurities. Whether this is true or not, there is a strong prejudice in favor of the imported kaolin. The

outline of the present method of washing the kaolin would apply to nearly all kaolin mines in this country, and appears to be rather crude, both in appliances and methods. It has been the method for many years, with very little change. Possibly careful experimental work might disclose better and safer methods; certainly the loss of half of the available kaolin is not good engineering practice. If the American potters could always rely on the American product being uniform and free from all impurities, the demand for imported kaolins would decrease, and there would be a larger market for the home product. The quantity of kaolin available in this field is practically unlimited.

"Chemical analyses of the North Carolina kaolins compare most favorably with those of the standard foreign kaolins. Limoges and Dresden clays have long been famous for finest grades of china and porcelain in Europe. Cornwall, England, kaolin is imported into this country in quantity, and it is claimed by many potteries that its equal cannot be obtained in the United States. A study of these analyses shows that the iron percentage in the North Carolina kaolins is as low, and in some cases lower, than in the foreign product. They carry practically no lime or magnesia, both elements being present in the foreign kaolins. The ratio of aluminum to silica is much less in the German and French clays than in the North Carolina kaolins, but the Cornwall clay shows but little difference in this ratio to these Southern kaolins. The French and German clays contain high silica and rather low alumina. The Mitchell County kaolins are very close to theoretically pure kaolin, containing 46.3 per cent silica, 38.8 alumina and 14 per cent water. The chemical characters of the Southern kaolins are seen to be very similar to the standard foreign clays. The physical properties also seem to be similar. The Cornwall clay is plastic, and North Carolina kaolins are usually described as nonplastic. Certain kaolins near Franklin recently examined by the writer were found to be plastic, and other plastic kaolins may also be found in this area on more detailed examinations.

"The kaolin from the mine has a very different character and appearance to the washed kaolin ready for the market. In some cases it is decidedly sandy, due to the amount of fine quartz grains, and in mass is usually snow white. In some samples the mica is in large plates, half inch across, and in others very minute pieces. It is not very difficult to remove the quartz sand, but the minute mica flakes adhere to the kaolin particles, and require most careful washing to entirely remove them. The Mitchell County washed kaolin shows a slight cream tinge, and under a lens this is seen to be due to minute

lumps of yellowish clay. In these mines minerals of the uranium group are found, and this tinge may be due to minute particles of such minerals or their alterations. In the Snow Creek area the washed kaolin lacks this tinge and is snow white, but here the alteration has been less, for partially altered feldspar is common through the kaolin. In the kaolin in Macon County near Franklin the quartz and mica are in very minute flakes, and the yield of washed kaolin was higher than in other localities examined. The washed product was snow white, and also plastic, and could be molded into shapes, retaining them when dry. It is impossible to make any tonnage estimates in these areas, on account of small development, and the prospect openings are small and scattered, but there is an enormous tonnage available.

"With large deposits of plastic and nonplastic kaolins and other necessary ingredients of the china and porcelain mixtures in close proximity in these areas, it appears strange that none of the product is made in the South. Two reasons for this condition are, first, the use of cheap natural gas fuel in the Ohio and West Virginia districts; and, second, the fact that the expert potters are a clannish people, who have settled in these leading districts for many years, and are slow to change to new locations.

"There has been a very great development of Southern industries in the past decade, and it would seem as though the time was at hand for the successful development of white-ware pottery for manufacture in the South, not only to supply their own demands, but for shipment into other territory."

Several kaolin deposits were examined during the summer of 1917 by Mr. John E. Smith, who reports as follows:

"Swain County: Hugh J. Sloan's Mines on property of A. J. Cunningham 4 miles south of Bryson City. Sloan has lease on 130 acres, began operation July 20, 1916, and has worked continuously since, except in January and February. The plant consists of a one-story drying shed 125 feet long, at one end of which are the cylindrical section presses (Canton Pump Company, Ohio) operated by hand power. Sand troughs; 2 settling tanks, 36 x 10 x 5; a receiving tank; 2 rotary beaters; 2 paddle wheel sand dippers; pumps, etc. Power is supplied by 40-horsepower engine on a 60-horsepower boiler. Water is supplied by means of a triangular box flume ½ mile or more in length. The clay is transported down the mountain side from the pits by means of a clay flume 800 feet long. From the pit to the flume the kaolin is brought by dump cars on tramway 500 feet to ½ mile long. The dried pressed kaolin is hauled by teams 1 mile to a siding on the Alarka Valley Railway (Lumber road).

"The first vein worked was the one nearest the plant, 5 to 15 feet wide with numerous stringers, 50 feet deep and 80 feet or more in length. Direction N. 50° E. Some quartz and mica occurred in this clay and some graphic granite was found in the bottom of this pit which is now abandoned. The second pit (in distance from the plant but not yet connected by rail) has a vein of clay 5 to 8 feet wide, 35 feet deep and length exposed 25 feet. This vein contains mica crystals 1 to 2 inches wide and up to 5 in length but much less quartz than in No. 3, also spots of black powdery clay produced by the decay of some original mineral. The stripping above this clay is 3 to 5 feet thick. This vein has a strike N. 30° E. and probably occurs in the mica schist exposed nearby in the excavation from the tunnel. Very little clay has been removed from this pit. Pit No. 3 in distance from the plant ½ mile. This pit when visited was laid open but has not been worked to any great extent. Width 15 feet, depth proved by boring and exposure 40 feet, length proved by tunnels 70 feet. The clay bears a few cross seams of brown limonitic clay up to 1 foot in thickness. Small crystals of decayed mica ½ inch to 1 inch were seen near the margin and a small quantity of quartz is distributed throughout. No fresh feldspar was visible. This is a pretty white clay and gives promise of yielding well. The bearing of this dike is N. 87° E., only 3° from due E. The overburden exposed varies from 1 to 6 feet in thickness and the exposure is on a hillside where the dirt may be easily cast aside. The wall rock bordering the clay is entirely decayed but shows numerous thin streaks indicating that it was formerly a gneiss and decomposed in place. A tramway is being laid to this pit. Grading was completed, the ties placed, but the rails not yet distributed.

"Jackson County: At Dillsboro is a new plant on the Tuckaseegee River, 3½ miles from Sylva, owned by Charles J. Harris Clay Company. It was built in August, 1916, and began operating in March, 1917. This is known as the Rhoda plant. The mine is located about 7 miles up the river and is worked by means of a shaft, and the clay washed through the sand troughs into a flume 7 miles long leading to the screens and settling tanks at the plant. Two large filter presses, one square and one cylindrical, are installed on the second floor; the circular one contains gaskets (rubber band at margin of press to prevent loss in pressing). The building is 160 feet long and the upper floor, exclusive of the press room, is used as a drying shed and is 130 feet long. The dry clay is dropped through trap doors to the first floor and from there weighed and loaded into wagons. Four teams and teamsters are employed in hauling to Sylva and seven other men find work at the plant.

"There are three settling tanks, each 40 x 9 x 6 feet outside measurement, and a slip tank of the same dimensions between this three and the drying shed from which it is pumped to the filter presses. The product of refined clay is about one carload per week. It is shipped to Trenton, N. J., and to East Liverpool, Ohio.

"The Harris Company are also working several other kaolin pits in Jackson County."

Production

There is given in the table below the production of koalin in North Carolina for the years 1900–1917, inclusive:

PRODUCTION OF KAOLIN IN NORTH CAROLINA FROM 1900—1917, INCLUSIVE.

Year	Amount	Value
	Tons	
1900	7,000	$ 62,440
1901	15,575	119,172
1902	13,322	108,105
1903	8,605	76,000
1904	9,110	76,670
1905	10,988	85,622
1906	10,803	90,036
1907	11,035	85,505
1908	10,532	85,300
1909*	12,097	99,174
1910*	14,080	119,040
1911	14,903	130,610
1912	14,950	109,717
1913	16,332	139,629
1914	17,168	164,334
1915	15,699	143,505
1916	17,392	151,688
1917*	17,426	182,176

*Contains small amount of fire clay, stoneware clay and brick clay.

Producers

The following were producers of kaolin during 1917:

J. A. Smith, Bessemer City, Gaston County.
The Hand Clay Co., Canton, Haywood County.
Harris Clay Co., Dillsboro, Jackson County.
Intermont China Clay Co., Bandana, Mitchell County.

POTTERY CLAY

Although North Carolina has a comparatively large number of active potteries reporting a production of pottery products, yet the industry is of little importance as compared with the pottery industry of the

country at large. The *Charlotte Observer* of October 16, 1916, contained the following editorial:

"The Pottery Business

"An item copied in The Observer about a wagon load of crocks, jars and jugs arriving at Mocksville from a pottery in Catawba County, reminds the *Wilmington Star* of the time when the pottery flourished in this section of North Carolina. It is still an industry of considerable consequence. 'Mecklenburg,' says *The Star*, 'used to have two jug factories, strictly rural industries,' and it thinks there is no reason why the ceramic industry should not flourish in western North Carolina, for the geologists state that the several varieties of clays to be had in great abundance 'are among the finest to be found in America.' The pottery industry at one time was of commercial importance to Lincoln, Catawba, and adjoining counties and had attained extensive proportions at the outbreak of the Civil War. The old Potter's road that runs by Charlotte to the north and east, secured its name by reason of the fact that it was the direct route from the potteries in these counties to Charleston, which was the pottery market for this section of the South. This industry might still be revived on a profitable basis, but the world has probably picked up too fast a pace for it, or maybe the pottery heirs and assigns are too lazy to keep the wheels going."

Production

In the table below there is given the value of the pottery products in North Carolina, by counties, for the years 1913-1917, inclusive:

Value of the Pottery Products of North Carolina, by Counties, From 1913—1917, Inclusive.

County	1913				1914			
	Earthenware	Stoneware	Miscellaneous	Total	Earthenware	Stoneware	Miscellaneous	Total
Alamance	$ 160	$ 240	$	$ 400	$ 160	$ 240	$	$ 400
Buncombe	1,150	2,200	1,000	4,350	50	2,500	241	2,791
Catawba	125	2,940		3,065	398	2,413		2,811
Lincoln	58	1,645		1,703	101	1,575		1,676
Moore	440	800		1,240	400	800		1,200
Randolph	340	1,192		1,532	318	2,400		2,718
Union		400		400		350		350
Wilkes	45	948		993	50	800		850
Totals	2,318	10,365	1,000	13,683	1,477	11,078	241	12,796

County	1915				1916				1917			
	Earthenware	Stoneware	Miscellaneous	Total	Earthenware	Stoneware	Miscellaneous	Total	Earthenware	Stoneware	Miscellaneous	Total
Alamance	$150	$150	$----	$300	$150	$150	$----	$300	$200	$300	$----	$ 500
Buncombe	850	1,100	700	2,650	265	1,830	765	2,860	700	1,100	450	2,250
Catawba	148	2,219	------	2,367	550	2,416	------	2,966	159	1,656	------	1,815
Lincoln	380	1,300	------	1,680	200	1,560	------	1,760	100	960	------	1,060
Moore	300	500	------	800	------	300	------	300	50	400	------	450
Randolph	635	1,365	------	2,000	------	------	------	------	------	------	------	------
Union	------	381	------	381	------	374	------	374	------	------	------	------
Wilkes	41	1,175	------	1,216	125	1,175	------	1,300	60	1,340	------	1,400
Totals	2,504	8,190	700	11,394	1,290	7,805	765	9,860	1,269	5,756	450	7,475

In the following table there is given the total value of the pottery products in North Carolina, by counties, for the years 1913-1917, inclusive:

PRODUCTION OF POTTERY IN NORTH CAROLINA, 1900—1917.

Year	Value
1900	$ 18,863
1901	22,495
1902	14,512
1903	14,312
1904	13,900
1905	13,319
1906	11,770
1907	10,222
1908	13,362
1909	18,709
1910	14,990
1911	8,556
1912	8,950
1913	13,683
1914	12,796
1915	11,394
1916	9,860
1917	7,475

FIRE CLAY AND PIPE CLAY

There is included under this head fire and pipe clay and shales and products manufactured from them such as fire brick, sewer pipe, drain tile, fancy tile, flue linings, terra-cotta, etc. The portion of the productions of these clays and shales is from Guilford County.

Production

There is given in the table below the productions of fire clay, shale and pipe clay and the products manufactured from them for the years 1901–1917, inclusive:

PRODUCTION OF FIRE CLAY AND CLAY PRODUCTS IN NORTH CAROLINA, 1901—1917.

Year	Fire Brick		Sewer Pipe, Tile, etc.	Crude Clay	
	Quantity	Value		Tons	Value
1901	55,000	$ 550	$ 55,745	----------	$ 100
1902	----------	1,203	72,618	----------	215
1903	407,500	5,250	100,989	231	875
1904	163,000	2,700	110,800	80	700
1905	681,000	8,333	102,445	57	494
1906	401,000	7,180	113,900	19	185
1907	194,000	3,490	142,000	903	986
1908	700,000	7,560	19,335	2,298	349
1909	----------	----------	133,925	----------	753
1910	----------	----------	163,555	80	40
1911	130,000	1,800	185,804	81	56
1912	324,000	4,430	205,745	20	104
1913	----------	----------	230,904	20	15
1914	----------	----------	216,850	605	303
1915	*----------	†----------	205,100	370	191
1916	----------	----------	283,000	170	135
1917	*----------	----------	292,000	†----------	†----------

*Small quantity included with Front Brick in table on page 140. †Included under Kaolin, page 140.

It is interesting to note the steady increase in the value of the production of this type of clay products, particularly of the sewer pipe, tile, etc.

Producers

Those producing these clays and manufactured products during 1917 were as follows:

Joseph H. Vincent, Snow Camp, Alamance County.
Reems Creek Pottery Works, Brankton, Buncombe County.
W. M. Penland, Candler, Buncombe County.
Omar Khoyyam Pottery, Candler, Buncombe County.
W. H. Blackburn, Newton, Catawba County.
Reinhardt Bros., Lincolnton, Lincoln County.
Robt. D. Ritchey, Prop., Henry, Catawba County.
Wade D. C. Johnson, Henry, R.F.D. 2, Catawba County.
J. A. Propst & Son, Henry, R.F.D. 2, Catawba County.
R. P. Speagle, Newton, R.F.D. 1, Catawba County.
Royal M. Stallings, Henry, R.F.D. 2, Catawba County.

S. L. Hartsoe, Henry, Catawba County.
M. L. Leonard, Henry, R.F.D. 1, Catawba County.
Manager, Home Pottery, Steeds, Moore County.
W. T. Brackett, Henry, R.F.D. 2, Catawba County.
John W. Teague, Steeds, Moore County.
Wilkesboro Pottery Works, Wilkesboro, Wilkes County.

BRICK CLAY

There has been considerable advance in the method of manufacture of common brick in North Carolina, and the following description of a plant which has recently been installed will be of interest.

"$100,000 Brick Plant Begins Operation in North Carolina*

By Fred A. Olds

"Exceptional construction and other features are said to be embodied in the up-to-date brickmaking plant just put in operation at Brickhaven, Chatham County, North Carolina, by the Cherokee Brick Company of Raleigh. The plant, which is to have a daily output of 100,000 brick and employ 50 men, is located in the valley of the Cape Fear River, where there is a large deposit of clay of a high type. Electric power, furnished by the Carolina Power & Light Company over a line built to Brickhaven for supplying the 450-horsepower required, is used throughout. A. R. D. Johnson is president; E. C. Hillyer, vice-president, and C. A. Johnson is the secretary and treasurer, all of Raleigh.

"As this plant was under construction when the war broke out and during the time the pessimists of the cotton country were predicting financial ruin for the South because of low-priced cotton, the determination of those backing the enterprise to bring it to a successful completion is an object-lesson illustrating what can be accomplished under such conditions by men who have faith in their ability and in their country.

"Modern methods of handling are utilized from the time the clay is dug by a steam shovel, loaded on steel dump cars and hauled by a locomotive to the point where it is prepared, tempered and made into the finished product. Details of the handling of the material were worked out and perfected by Vice-President Hillyer, who also did the necessary general engineering work and superintended the construction of the plant. The problem of handling the large production, both into

Manufacturer's Record, November 25, 1915, page 46.

and out of the kilns, has been minimized to the last degree by the use of mechanical devices and electric power to eliminate work usually done by hand.

"From the point where the clay is prepared and made into bricks the latter are taken on steel cars and carried to the dryer. After drying they are conveyed by a traveling crane to the kilns, where the "setters" take them from the dryer cars, placed on turntable platforms and set the brick. The crane service successfully eliminates "tossing," thereby facilitating the setting, besides reducing this part of the manufacturing cost.

"Unusually high and wide kilns have been built, higher than ever attempted where the brick are tossed. This method of construction is said to reduce the proportion of salmon brick and effect the greatest possible economy in fuel. Steel-trussed, metal-covered, permanent roofs cover all the kilns.

"From the kilns a traveling crane takes the burned brick, 700 at a time, and loads them into gondola cars. At least four-fifths of the breakage due to the usual method of handling by means of wheelbarrows is said to be eliminated. The crane service for shipping also makes possible the shipment of brick at a rate not attainable by other methods of loading cars. The company loads and ships out of one kiln a car of brick in an hour, and is equipped for carrying on this part of the work at night as well as by day.

"The handling of coal both for drying and burning the brick is done with the greatest dispatch and at the lowest cost, due to the economy and efficiency of the method designed and carried out by Mr. Hillyer."

Production

The production of the various types of brick that were manufactured from brick clay, such as common brick, pressed brick, fancy brick, etc., is dependent largely upon the demand for builders' materials. There has been a steady increase in the number and value of common brick manufactured during the past 4 years, despite war conditions, which have tended to cut down construction work. In 1913 there were 204,097,000 common brick manufactured, valued at $1,354,062. This was an increase over the 1912 production of 11,039,000 brick and of $117,619 in value. The 1913 production was the largest production yet made in the State, as will be seen from the table given below. There was a decrease in the production of common brick during 1914 and

1915, with a slight picking up in 1916 and another slight decrease in 1917. The average value of common brick per thousand in 1913 was $6.63 as compared with $6.40 in 1912. In 1914 the average value per thousand was $6.62; in 1915 the average value per thousand dropped to $6.14; in 1916, it advanced to $6.38; and in 1917, the price advanced to $7.84 per thousand.

The table below gives the number and value of common brick manufactured in North Carolina, by counties, for the years 1913 to 1917, inclusive. Where there were less than three producers in a county, they are combined in groups.

PRODUCTION OF COMMON BRICK IN NORTH CAROLINA DURING 1913—1917, BY COUNTIES.

County	1913		1914		1915		1916		1917	
	Number Common Brick	Value	Number Common Brick	Value	Number Common Brick	Value	Number Common Brick	Value	Number Common Brick	Value
Alamance	4,950,000	$ 31,275	3,650,000	$ 22,800	2,250,000	$ 12,000	4,340,000	$ 24,540	4,040,000	$ 29,680
Anson										
Beaufort	5,237,000	39,276	4,090,000	28,570	3,562,000	21,129	1,714,000	12,255	750,000	6,000
Bertie										
Buncombe	6,300,000	37,800	6,200,000	38,450	5,256,000	34,308	4,950,000	31,250	2,150,000	16,225
Burke										
Cabarrus	2,300,000	16,250	2,100,000	12,000						
Caldwell	2,140,000	12,540	1,807,000	10,581	1,143,000	7,141	712,000	4,084	25,902,000	195,348
Camden	1,365,000	8,030	1,521,000	9,287	495,000	3,090				
Catawba										
Chatham	2,300,000	14,500	2,500,000	16,750	7,200,000	40,300	25,701,000	150,782		
Chowan										
Cleveland	2,950,000	18,700	1,808,000	11,470	1,160,000	8,210	1,798,000	11,738	2,721,000	19,048
Columbus										
Craven	10,154,000	64,910	12,866,000	78,161	9,421,000	52,527	11,908,000	71,124	14,223,000	106,818
Cumberland	3,880,000	24,500					3,600,000	22,600		
Davidson					2,075,000	12,600	500,000	3,600	325,000	2,547
Davie	472,000	3,317	262,000	1,865						
Duplin										
Durham	5,300,000	39,350	5,176,000	37,331	4,811,000	34,177	3,668,000	27,274	2,176,000	19,232
Edgecombe	700,000	4,800	525,000	3,050	550,000	3,900	300,000	2,000		
Forsyth	6,890,000	48,846	7,600,000	49,690	4,150,000	25,800	5,206,000	33,800	3,775,000	28,600
Gaston	5,096,000	36,368	7,400,000	54,240	8,450,000	50,700	12,400,000	74,400	10,194,000	74,960
Granville	873,000	7,572	5,340,000	37,263	4,868,000	36,813	5,024,000	36,755		
Guilford	8,084,000	51,222							2,337,000	22,806
Halifax	6,950,000	51,050	6,800,000	49,300	4,753,000	29,995	6,500,000	44,050	4,650,000	34,150
Harnett										
Henderson	8,700,000	56,200	6,937,000	41,846	6,288,000	36,050	12,911,000	77,267	10,813,000	73,366
Hoke										
Iredell	7,917,000	58,347	8,219,000	52,668	6,357,000	40,837	8,100,000	54,550	8,693,000	70,870
Johnston										

Lee			2,075,000	15,675	1,470,000	9,030				
Lenoir	1,566,000	7,600					2,800,000	18,800	2,875,000	22,475
Lincoln							1,196,000	9,629		
Madison	1,575,000	11,270	1,960,000	12,960			8,895,000	57,899	800,000	6,400
Martin										
Mecklenburg	8,700,000	56,500	6,875,000	42,150	6,827,000	40,957			8,790,000	68,804
Montgomery	1,430,000	9,440					344,000	2,108		
Moore	3,900,000	27,000	5,729,000	40,100	5,250,000	35,400	5,300,000	41,800	5,890,000	43,700
Nash										
New Hanover										
Orange	5,615,000	41,625	5,500,000	38,500	5,000,000	37,000	3,000,000	18,000	7,948,000	62,658
Pamlico										
Pasquotank			2,050,000	13,050	2,230,000	13,680	1,800,000	10,800	1,800,000	14,300
Pender	2,100,000	11,900								
Perquimans	6,310,000	47,180	8,275,000	57,550						
Pitt					6,870,000	40,615	4,500,000	29,100	5,710,000	49,600
Randolph	4,850,000	29,475	1,925,000	12,188	2,650,000	16,725	3,300,000	20,625	2,546,000	17,500
Richmond			1,370,000	9,250						
Robeson	3,555,000	23,959			1,400,000	8,800	2,465,000	15,250	1,483,000	11,933
Rockingham			2,160,000	14,630	1,400,000	8,800	1,100,000	7,600	1,300,000	12,600
Rowan	6,167,000	38,550	6,600,000	41,200	5,471,000	30,200	5,621,000	35,600	5,000,000	38,081
Rutherford	970,000	7,550	400,000	2,850	602,000	4,700			800,000	6,800
Sampson							1,000,000	7,000		
Stanly	12,113,000	74,420	5,125,000	31,275	4,100,000	22,300	4,800,000	30,600	10,500,000	81,000
Stokes			6,921,000	44,640	6,085,000	35,002	5,000,000	30,000		
Surry	680,000	3,980	2,350,000	15,950	700,000	5,350	1,395,000	11,627	355,000	2,655
Union	1,600,000	10,400	870,000	5,475						
Vance										
Wake	11,800,000	63,000	7,950,000	45,900	2,400,000	14,050	5,897,000	35,119	3,156,000	25,600
Washington					578,000	4,733	1,200,000	7,400	1,240,000	8,780
Watauga	*a*									
Wayne	33,300,000	230,000	25,682,000	177,775	11,247,000	68,000	21,300,000	142,000	17,000,000	149,175
Wilkes	2,008,000	10,060	*b*							
Wilson	3,300,000	25,300	4,000,000	34,500	3,188,000	17,472	3,019,000	21,900	2,900,000	24,500
Yadkin			1,030,000	5,240						
Totals	204,097,000	$1,354,062	183,648,000	$1,216,180	140,257,000	$ 862,391	193,264,000	$1,234,926	172,842,000	$ 1,346,211

*a*Included under Wilkes. *b*Included under Yadkin.

Producers of Brick and Tile in North Carolina During 1917

County	*Name*	*Address*
Alamance	W. C. Michael	Elon College, N. C.
	Parks & Jeffreys	Graham, N. C.
	Trolinger & Montgomery	Mebane, N. C.
	Maben L. Stuart	Sylvester, N. C.
Beaufort	Pamlico Brick & Tile Co.	Washington, N. C.
Buncombe	Geo. C. Shehan Brick Co.	Asheville, N. C.
Burke	Morganton Brick Co.	Morganton, N. C.
Caldwell	Powell Bros. Brick Co.	Lenoir, N. C.
Catawba	L. W. Poovey Brick Co.	Hickory, N. C.
	E. M. Deal	Newton, N. C.
Chatham	B. N. Welch	Bear Creek, N. C., R. 1
	Johnson & Johnson Co.	Brickhaven, N. C.
	C. N. Bray & Bro.	Siler City, N. C.
Chowan	Edenton Brick Works	Edenton, N. C.
	Tuttle & Bell	Edenton, N. C.
Cleveland	J. A. Falls	Kings Mountain, N. C.
Columbus	Williamston & Nance	Cerro Gordo, N. C.
	Oscar High	Whiteville, N. C.
Craven	Clark Brick & Tile Co.	Clark, N. C.
	Geo. T. Eubanks	Clark, N. C.
	Carolina Brick Co.	Kinston, N. C.
	New Bern Brick Co.	New Bern, N. C.
	H. M. Wethington	Vanceboro, N. C.
	Peoples Brick Co.	New Bern, N. C.
Cumberland	E. A. Poe Brick Co., Inc.	Fayetteville, N. C.
Davidson	L. A. Smith	Denton, N. C.
	Ragan Brick Co.	Thomasville, N. C.
Durham	Cheek & Belvin	Durham, N. C.
	R. Fitzgerald	Durham, N. C.
Forsyth	Adrian L. Dean	Kernersville, N. C.
	B. X. & R. T. Linville	Kernersville, N. C., R. 4
	R. F. Byerly & Co.	Winston-Salem, N. C.
	R. W. Hedgecock	Winston-Salem, N. C.
	R. L. Whitfield & Co.	Winston-Salem, N. C.
Gaston	Kendrick Brick & Tile Co.	Mt. Holly, N. C.
	A. B. Lewis	Belmont, N. C.
	Gaston Brick Co.	Charlotte, N. C.
	Mo-Ho Brick Co.	Mt. Holly, N. C.
	Harrison & Ellington	Lowell, N. C.
Guilford	Cunningham Brick Co.	Greensboro, N. C.
	J. G. Williams	Greensboro, N. C.
	Pomona Terra-Cotta Co.	Pomona, N. C.
Halifax	J. W. Madry	Scotland Neck, N. C.
	Chokoyotte Brick Co.	Weldon, N. C.

County	*Name*	*Address*
Halifax (Cont.)	L. N. Gant	Weldon, N. C.
	Weldon Brick & Land Improvement Co.	Weldon, N. C.
Henderson	D. S. Hildebrand	Brickton, N. C.
	Asheville Brick & Tile Co.	Fletcher, N. C.
	J. C. Sherrill	Hendersonville, N. C.
Iredell	Statesville Brick Co.	Statesville, N. C.
Johnston	Selma Brick Co.	Selma, N. C.
	C. W. Beasley	Smithfield, N. C.
Lee	Goldston Brick Co.	Cumnock, N. C.
	Thomas Bros. Brick Co.	Jonesboro, N. C.
Lenoir	Moseley Brick & Shingle Co.	Kinston, N. C.
Madison	John R. Anderson	Mars Hill, N. C.
Martin	Martin County Brick & Tile Co.	Williamston, N. C.
Mecklenburg	Queen City Brick Co.	Charlotte, N. C.
	Riverside Brick Co.	Charlotte, N. C.
Montgomery	L. L. Richardson	Star, N. C.
Moore	W. M. Kivett	Carthage, N. C.
Nash	Tar River Brick Co.	Rocky Mount, N. C.
New Hanover	Roger Moore's Sons & Co.	Wilmington, N. C.
Orange	J. T. Fowler	Hillsboro, N. C.
Pasquotank	Elizabeth City Brick Co.	Elizabeth City, N. C.
Pender	J. T. Harrell	Burgaw, N. C.
Pitt	W. J. Gardner & Son	Bethel, N. C.
	Farmville Brick Co.	Farmville, N. C.
	W. H. Dail, Jr.	Greenville, N. C.
Randolph	W. L. Foust	Ashboro, N. C.
	Elmer Rich	Ashboro, N. C.
	Glenola Brick Co.	High Point, N. C.
	Liberty Brick Co.	Liberty, N. C.
	B. W. Walden	Randleman, N. C.
Robeson	C. M. Reaves	Proctorville, N. C.
	Bracey Bros. Brick Co.	Rowland, N. C.
Rockingham	J. M. Hopper	Leaksville, N. C.
	James A. Foust & Son	Madison, N. C.
	Jennings & Ware	Reidsville, N. C.
Rowan	Nessman-Kennedy Brick & Lumber Co.	Salisbury, N. C.
	Yadkin River Brick Yard	Salisbury, N. C.
	Isenhour Brick Co.	Salisbury, N. C.
Rutherford	Martin D. Hill	Rutherfordton, N. C.
Sampson	J. B. Bryan	Roseboro, N. C.
Stokes	Shale Paving Brick and Fire Roofing Co.	Pine Hall, N. C.
	Hedgecock Brick Co.	Walnut Cove, N. C.

County	*Name*	*Address*
Surry	John W. Gardner	Mount Airy, N. C., R. 3
	J. L. Banner	Mount, Airy, N. C.
	C. C. Midkiff	Mount Airy, N. C., R. 2
Wake	Holly Springs Land and Improvement Co.	Holly Springs, N. C.
	Raleigh Brick Co.	Raleigh, N. C.
	Johnson & Johnson Co.	Raleigh, N. C.
Washington	Plymouth Brick Co.	Plymouth, N. C.
Watauga	Boone Brick Co.	Boone, N. C.
Wayne	Borden Brick & Tile Co.	Goldsboro, N. C.
	Wayne Red Brick Co.	Goldsboro, N. C.
	H. Weil & Bros.	Goldsboro, N. C.
Wilkes	Houck & Henry	North Wilkesboro, N. C.
Wilson	Wilson Clark Brick Co.	Wilson, N. C.

SUMMARY

There is given in the table below the value of the mineral production of each county in North Carolina for the years 1912–17, inclusive:

VALUE OF MINERAL PRODUCTION IN NORTH CAROLINA, 1912—1917, INCLUDING CLAY PRODUCTS.

County	Total Value of Mineral Production					
	1912	1913	1914	1915	1916	1917
Alamance	$ 28,400	$ 26,075	$ 21,700	$ 12,300	$ 24,856	$ 30,180
Alexander	624	380	528	269	226	103
Alleghany	300	500	875	----------	----------	100
Anson	7,104	110,572	41,516	10,110	113,399	92,906
Ashe	5,300	3,500	1,500	2,604	3,460	28,962
Avery	186,264	238,450	125,687	182,904	324,568	447,717
Beaufort	16,048	29,500	18,070	12,500	6,000	6,000
Bertie (*a*)	10,527	12,276	10,500	8,629	7,255	----------
Bladen	----------	----------	----------	----------	----------	----------
Brunswick	----------	----------	----------	----------	----------	----------
Buncombe	75,114	71,122	40,303	28,275	37,366	47,821
Burke	14,104	17,233	15,246	9,649	11,413	51,809
Cabarrus	23,735	16,798	12,022	282	462	750
Caldwell	16,386	12,752	11,184	7,292	4,184	3,125
Camden (*b*)	----------	1,500	2,287	1,715	----------	----------
Carteret	----------	----------	----------	----------	----------	----------
Caswell	----------	50	1,000	444	375	300
Catawba	12,510	9,846	22,209	144,574	5,250	13,315
Chatham	6,250	4,125	3,190	26,380	143,566	164,223
Cherokee	33,134	36,663	62,669	69,937	55,064	144,434
Chowan (*b*)	8,400	10,500	13,750	14,000	15,407	16,848
Clay	1,200	6,000	----------	----------	----------	1,200
Cleveland	15,429	18,003	11,330	12,904	9,103	7,516
Columbus	7,500	11,600	3,000	5,700	4,250	25,656
Craven	59,150	68,760	64,011	62,127	78,624	79,986
Cumberland	33,316	27,500	29,886	17,940	23,600	26,905
Currituck	----------	----------	----------	----------	----------	----------
Dare	----------	----------	----------	----------	----------	----------
Davidson	34,271	22,998	34,500	38,000	3,600	24,569
Davie	1,400	1,200	----------	----------	----------	----------
Duplin (*c*)	80	197	165	----------	----------	----------
Durham	41,040	41,460	39,896	35,277	28,074	21,608
Edgecombe	18,410	4,800	3,050	3,900	2,000	----------
Forsyth	45,893	48,930	55,490	27,150	33,800	28,600
Franklin	1,228	----------	----------	----------	200	1,100
Gaston	27,756	40,590	61,335	124,505	137,715	345,420
Gates	----------	----------	----------	----------	----------	----------
Graham	----------	----------	----------	----------	----------	----------
Granville	14,869	18,672	12,312	20,129	11,802	5,827
Greene	----------	----------	----------	----------	----------	----------
Guilford	273,150	281,542	249,263	240,291	314,430	315,301
Halifax	58,933	53,601	54,756	30,320	44,050	39,322
Harnett	1,500	26,685	3,660	20,220	14,500	13,776
Haywood	5,912	6,541	5,080	9,200	38,250	59,840
Henderson	98,417	82,202	85,100	119,584	195,345	226,397
Hertford	----------	----------	----------	----------	----------	----------
Hoke	----------	1,200	1,600	300	----------	----------
Hyde	----------	----------	----------	----------	----------	----------

*a*Included with Beaufort County. *b*Included with Caldwell County. *c*Included with Durham County.

VALUE OF MINERAL PRODUCTION IN NORTH CAROLINA, 1912-1917, INCLUDING CLAY PRODUCTS—Continued.

County	Total Value of Mineral Production					
	1912	1913	1914	1915	1916	1917
Iredell	$ 24,466	$ 29,834	$ 35,764	$ 27,157	$ 36,928	$ 49,945
Jackson	63,413	72,717	71,989	63,096	52,686	95,236
Johnston	28,550	40,000	32,400	24,800	34,200	38,000
Jones	15,100	----------	----------	----------	9,000	18,000
Lee	2,950	----------	2,175	1,730	6,200	16,183
Lenoir	6,000	7,000	15,000	8,400	12,600	16,000
Lincoln	3,295	2,303	1,676	3,855	1,760	1,060
McDowell	615	1,019	2,426	500	900	1,800
Macon	91,300	82,748	73,190	5,355	68,543	121,643
Madison	12,400	45,030	39,676	33,885	70,458	63,640
Martin	8,125	5,620	7,030	3,620	2,800	4,000
Mecklenburg	105,817	127,486	98,200	61,069	98,526	112,822
Mitchell	238,192	226,220	214,532	315,647	186,839	262,030
Montgomery	162,501	126,198	88,553	95,233	6,541	3,700
Moore	41,901	31,428	14,410	56,395	32,031	24,001
Nash	21,000	21,000	35,000	28,000	40,000	40,500
New Hanover	40,839	38,763	42,763	25,888	18,000	25,658
Northampton	----------	----------	----------	----------	----------	51,648
Onslow	350	----------	----------	----------	----------	----------
Orange	10,500	8,625	10,500	17,500	----------	37,000
Pamlico	----------	----------	----------	----------	----------	----------
Pasquotank	7,600	9,000	9,750	10,400	9,600	8,800
Pender	18,000	11,900	4,912	3,430	1,200	5,500
Perquimans	4,000	2,100	2,000	----------	----------	----------
Person	----------	----------	718	500	----------	----------
Pitt	36,800	45,080	55,550	40,615	29,100	49,600
Polk	10,338	26,041	18,115	----------	----------	----------
Randolph	15,320	33,501	14,957	18,725	20,625	18,300
Richmond	----------	----------	700	----------	----------	----------
Robeson	17,634	17,050	8,550	8,810	15,250	11,933
Rockingham	51,839	63,323	75,437	98,910	93,420	97,890
Rowan	382,571	411,608	438,757	308,099	540,643	583,639
Rutherford	5,315	2,984	3,797	7,707	7,022	9,105
Sampson	6,300	5,200	2,150	3,700	7,000	3,600
Scotland	----------	----------	----------	----------	5,575	6,660
Stanly	19,640	24,000	152,076	26,480	339,792	40,810
Stokes	42,890	52,745	47,427	37,022	31,566	46,169
Surry	422,227	481,917	526,907	605,201	506,873	513,968
Swain	46,318	35,689	29,140	23,001	12,955	17,950
Transylvania	2,800	2,300	1,100	1,060	2,300	3,100
Tyrrell	----------	----------	----------	----------	----------	----------
Union	31,004	13,816	3,945	8,454	11,470	18,163
Vance	21,890	18,600	10,400	4,770	123,600	45,892
Wake	74,250	63,000	99,633	63,030	40,844	79,909
Warren	25,757	30,932	15,856	2,086	3,780	535
Washington	12,000	----------	----------	2,233	6,000	7,980
Watauga	212	760	500	3,000	2,300	3,075
Wayne	165,794	236,337	181,043	77,030	145,750	149,525
Wilkes	6,400	11,343	5,871	10,216	11,050	15,625
Wilson	16,375	37,000	70,976	62,299	191,949	113,334
Yadkin	----------	300	240	2,055	1,150	----------
Yancey	10,650	12,500	8,000	84,351	215,654	305,908
Totals	3,514,892	3,879,340	3,692,461	3,504,725	4,746,674	5,411,452

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Out of print.*

8. Water powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Out of Print.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, $1.00.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph. D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 75 cents.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs.

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Pastage 20 cents.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Out of Print.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a list of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Out of Print.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives, Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities; Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Out of Print.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interests in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp. 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolnia are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Out of print.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp. 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145, pp. 11 figs. *Out of print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur, as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc., the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp.

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and the North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection, held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 55 pp. *Postage 10 cents.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 90 pp. *Postage 15 cents.*

46. The Vegetation of Shackleford Bank, by I. F. Lewis, 1917. 8°, 40 pp., 11 pl. *Postage 10 cents.*

47. Proceedings of the Ninth Annual Drainage Convention of the North Carolina Drainage Association, held at Greensboro, N. C., November 22 and 23, 1916. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1917. 8°, 110 pp., 8 figs. *Postage 15 cents.*

48. Forest Fires in North Carolina during 1915, 1916 and 1917, and Present Status of Forest Fire Prevention in North Carolina, by J. S. Holmes, State Forester, 1918. 8°, 97 pp. *Postage 10 cents.*

49. Mining Industry in North Carolina during 1913–1917, Inclusive, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1919. 8°, 170 pp. *Postage 20 cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy $1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Out of Print.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Out of Print.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller and L. W. Stephenson.
Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. The Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley and H. H. Brimley, 1918. 8°, 380 pp., 24 colored plates, 10 black and white plates, 275 text figures, one map. *Paper copies, $2.00, postpaid. Cloth-bound copies, $2.75, postpaid.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving object and organization of the Survey; Investigations of Iron Ores, Buildng Stone, Geological work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry Reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the Woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915, 8°, 165 pp. *Postage 10 cents.*

Administrative report and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the Northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation, report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

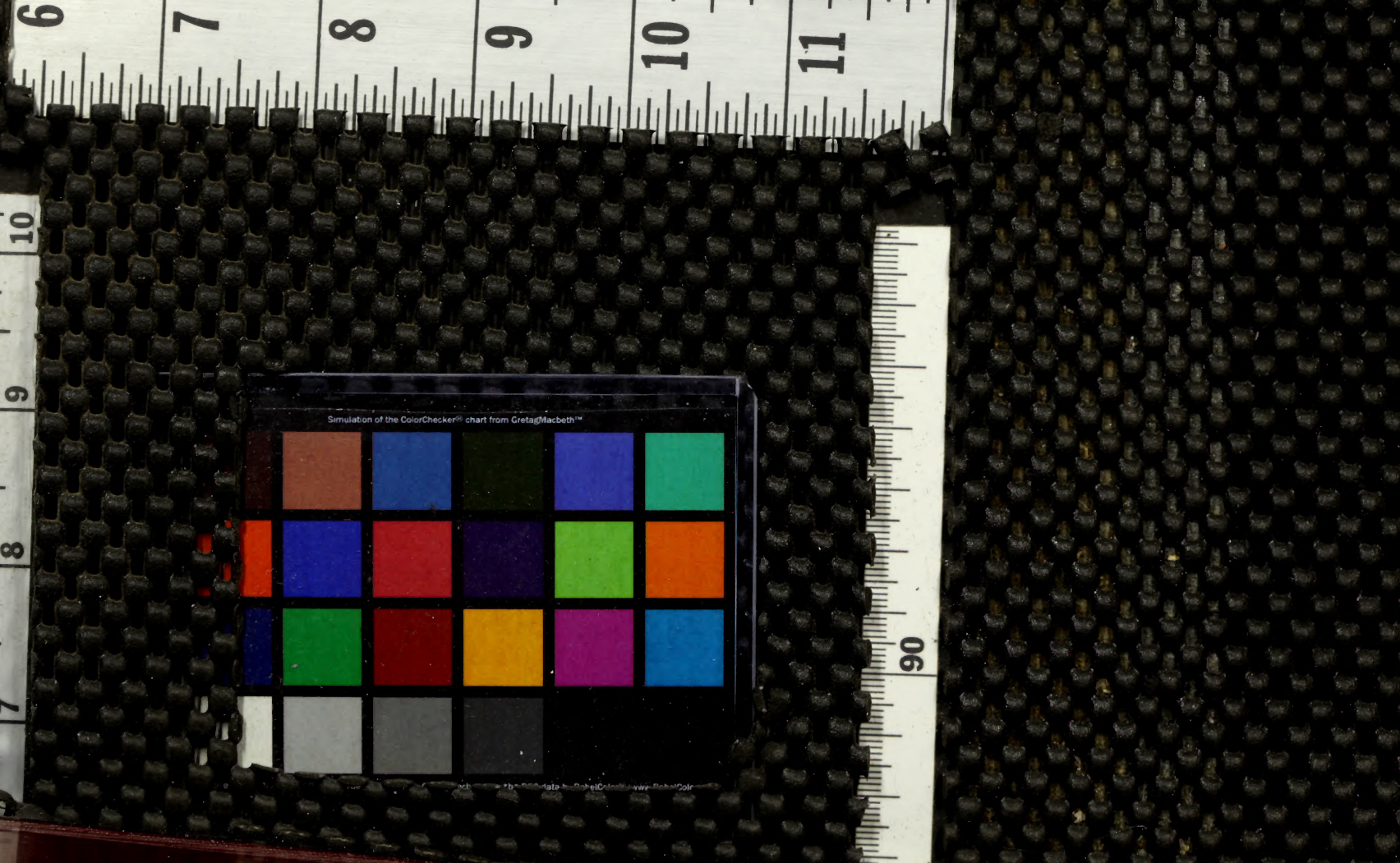
Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. *Postage 25 cents.*

Administrative report and contains special reports on the Protection from Fire of the Forested Watersheds of Navigable Streams; National Forest Reservations; forestry report on Lake Latham Farms near Mebane, N. C.; report on Forest Tract owned by the Cranberry Iron and Coal Company near Cranberry, N. C.; report on work of N. C. Forestry Association; report on Southern Forestry Congress; special report on "The Fisheries of North Carolina"; Magnetic Observations made during 1915 and 1916; Memorial Sketch of Dr. Joseph Austin Holmes.

Biennial Report, 1917-1918, Joseph Hyde Pratt, State Geologist, 1919. 8°, 110 pp. *Postage 15 cents.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, in most cases free of charge, except that in each case applicants for the reports should forward the amount needed for packing and transportation for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*


Simulation of the ColorChecker® chart from GretagMacbeth™